Chapter 2

Methods and Information Sources

In preparing this report, EPA has developed facility-specific data and analytical methods that reflect the complexity of the issues that are addressed herein. The facilities that generate the special study wastes vary considerably in the types of production operations and waste management techniques that they employ. Moreover, to examine in detail the broad array of study factors mandated by RCRA §8002(p), EPA had to develop approaches and methods that were sufficiently sophisticated to take into account the special nature of high volume mineral processing wastes. This chapter outlines the data sources and methods that the Agency employed to respond to the statutory study factors, beginning with a discussion of the major data collection initiatives that EPA's Office of Solid Waste conducted during 1989 and proceeding to a discussion of the approach that EPA employed to address the salient features and implications of mineral processing waste generation and management.

2.1 EPA Data Collection Activities

After a review of the issues surrounding the Mining Waste Exclusion for mineral processing wastes and its history, EPA's Office of Solid Waste conducted a number of data collection activities to supplement and update previous work. The focus of most of these efforts was site-specific. As a consequence, EPA has been able to compile detailed facility- and sector-specific information, which the Agency has used extensively to prepare this report as well as a series of rulemakings which, in combination, have clarified the boundaries of the Mining Waste Exclusion as it applies to mineral processing wastes (as discussed above). The major information-gathering initiatives are identified and discussed in the following paragraphs.

Public Comments

Over the course of the past several years, EPA has received a considerable volume of written comments addressing the scope of the Mining Waste Exclusion for mineral processing wastes. The Agency has reviewed these comments, and has utilized pertinent information to supplement its knowledge of waste generation and management, product markets, waste management alternatives, and other topics related to this report.

1989 National Survey of Solid Wastes from Mineral Processing Facilities (SWMPF Survey)

In early 1989, EPA prepared and submitted a written questionnaire to the operators of approximately 200 facilities that the Agency believed generated one or more solid wastes that might qualify for the Mining Waste Exclusion. These facilities were identified from information in existing Agency files, statements made in public comments on related proposed rulemakings, and from data supplied by the U.S. Bureau of Mines (BOM). The questionnaire was designed to elicit information on waste generation and management at mineral processing facilities, as well as on the operational characteristics of the facilities. The majority of the questions included in the survey questionnaire addressed waste management, and were ordered so as to "track" the wastes of interest from the point of generation through the ultimate disposition of all residuals.

Facility operator responses to the questionnaire provide nearly complete coverage of the facilities that currently generate one of more of the 20 special study wastes. Coverage for many of the 20 waste streams is complete, i.e., EPA has a census of all current generators of all but a few of these wastes. Responses to the questionnaire were encoded and entered into a computerized data base, which EPA has used in assembling the analyses described below. A description of the survey is presented in Appendix B-1 to this document. Copies of the survey instrument, as well as any non-confidential individual company responses to the questionnaire, may be found in the supporting docket for this report.

1989 Mineral Processing Waste Sampling and Analysis

Because many of the wastes considered in this report had not been studied by OSW previously, and because existing data for some of the other wastes is sparse, EPA conducted a waste sampling and analysis program during the summer of 1989. The Agency's field sampling teams visited 37 mineral processing facilities, recorded observations regarding operational practices, took photographs of waste management activities, and collected samples. In many cases, EPA took samples of candidate special mineral processing wastes on both an "as-generated" basis and on an "as-managed" basis. Analytical data derived from wastes as-generated were used extensively in support of the recent series of rulemakings addressing the scope of the Mining Waste Exclusion, while the as-managed data have been used as a primary source of waste characterization data in preparing this report. These data may be found in summarized form in the supporting docket for this report, while a description of EPA's 1989 waste sampling study is presented in Appendix B-2 to this report.

Damage Case Collection

To respond to the need to describe "documented cases in which danger to human health or the environment has been proved," (referred to in this report as "damage cases") as directed by the RCRA statute, EPA conducted an exhaustive examination of the extent to which any of the wastes considered in this report have been implicated in environmental contamination incidents. This effort began by contacting appropriate staff people in all EPA regions and states in which one or more facilities that does or did generate one of the 20 special mineral processing wastes is located. Where telephone contacts indicated that relevant damage case information might exist at the regional or state level, the information was obtained through the mail or through visits with state/local officials having regulatory jurisdiction over mineral processing waste management.

In some cases, personnel also visited the sites being evaluated. While in the field, EPA representatives obtained copies of information that might be relevant to evaluating a particular damage case. The result of this effort is a compilation of information regarding the past and present management practices that have been applied to special mineral processing wastes, and the environmental or human health consequences of these practices. Damage case findings are summarized by mineral commodity sector in the chapters that follow; the individual sites that have been evaluated in detail are listed in Appendix B-3. More extensive discussions and supporting evidence are provided in a technical background document that may be found in the supporting docket for this report.

EPA Site Visits

In addition to the waste sampling and damage case collection efforts described above, staff visited a number of active mineral processing operations during 1989 and 1990 in order to enhance the Agency's general understanding of the processes whereby special mineral processing wastes are generated, and of the techniques by which they are and could be managed. In total, EPA headquarters staff have, during the past two years, been on site and have observed the production and waste management operations at several dozen facilities representing all twelve of the mineral commodity sectors addressed herein. The knowledge and insights gained during these visits have enabled the Agency to understand and critically evaluate the adequacy of current waste management practices, and to draw conclusions and make recommendations regarding the regulatory status of the special mineral processing wastes.

RCRA §3007 Waste Characteristics Data Request

In order to augment existing EPA waste characterization data and to allow affected facilities to have meaningful input into the Agency's evaluation of the physical and chemical characteristics of temporarily exempt mineral processing wastes, EPA issued a formal written request, under authority of RCRA §3007, to facility operators seeking any currently available information on the characteristics of the candidate special mineral processing wastes that they generate. The request did not specify the quantity of data required by EPA or a data format, so as to make compliance by the facility operators as simple as possible. An example of the §3007 data request is presented in Appendix B-4 to this report.

Facility operators responded in a number of different ways, up to and including submitting hundreds of pages of process control data. EPA has reviewed all of these data submittals and has collected and summarized all data that are both useable (e.g., identity of waste stream and analytical testing method is clear) and relevant to this study.

2.2 Analytical Approach and Methods

EPA has consolidated its analysis of certain of the eight study factors identified in Chapter 1, so as to facilitate focused analysis and clear exposition of the information that is germane to the decisions at hand, i.e., whether Subtitle C regulation of any of the 20 special mineral processing wastes is appropriate. The Agency has employed this approach because several of the study factors overlap or are closely related to one another. Consequently, the sector-specific chapters that follow consist of an introduction, five substantive sections addressing the study factors, and a summary section.

The remainder of this chapter summarizes EPA's approach for addressing each of the required study factors. The sections that follow present the methods that the Agency has employed in preparing the six substantive parts of each sector-specific chapter:

- Section 2.2.1, Waste Generation, Characteristics, and Current Management Practices, describes the identification of facilities that generate one or more of the special study wastes, development of descriptions of production processes, product uses, general waste composition, and waste generation and management practices (study factors 1 and 2), as well as the relationship of this information to analysis of the remaining study factors.
- Section 2.2.2, Potential and Documented Danger to Human Health and the Environment, presents the approach that EPA used to assess the potential danger posed by each of the 20 wastes under study and identify proven cases of danger to human health and the environment (study factors 3 and 4).
- Section 2.2.3, Existing Federal and State Waste Management Controls, describes the Agency's approach to developing an improved understanding of current federal and state requirements that apply to special mineral processing wastes (as suggested by §8002(p) of RCRA, independent of the eight study factors).
- Section 2.2.4, Alternative Management Practices and Potential Utilization, discusses the identification and evaluation of alternatives to current waste management and utilization practices (study factors 5 and 8).
- Section 2.2.5, Cost and Economic Impacts, presents the Agency's approach to specifying alternative regulatory scenarios and estimating the associated costs and economic impacts (study factors 6 and 7).
- Section 2.2.6, Summary, provides a description of the way in which EPA has evaluated the study factors, in order to facilitate future regulatory decision-making.

2.2.1 Waste Characteristics, Generation, and Current Management Practices

To characterize the generation and management of each of the 20 special mineral processing wastes, EPA needed to identify the facilities that generate the wastes, the production processes used and the products produced, the quantity and characteristics of the wastes generated, and the practices that are employed to manage them. EPA's approach to addressing each of these needs is described below, followed by a discussion of the relationship of the resulting information to the other study factors.

Affected Facilities

The identification of the facilities that generate one or more of the twenty special wastes was begun during the reinterpretation of the Mining Waste Exclusion for mineral processing wastes. This rulemaking process began in August, 1988 and continued through the publication of a final rule in January 1990. Beginning with previous EPA studies and additional published sources (e.g., SRI International's Directory of Chemical Producers--United States, 1989 Ed.), and relying extensively on support from Commodity Specialists with the U.S. Bureau of Mines, the Agency established a list of facilities that were believed to produce a mineral commodity of interest and potentially generate a special waste. The operators of these facilities were sent a survey requesting information on waste generation and management. A brief discussion of the survey is provided above in Section 2.1. Survey responses allowed EPA to finalize its list of the active facilities in the mineral processing sectors of concern. Production data (e.g., quantity of the primary commodity produced, the age and capacity of the operation) were also obtained from these surveys.

Process Descriptions and Product Use(s)

Process descriptions were developed to characterize the major type(s) of process operations employed in each sector. Detailed discussion of waste generation from these processes within this report is limited to the special waste(s) within each commodity (i.e., one of the twenty waste streams studied in this report) and does not involve other wastes or secondary materials that may be generated.

Information regarding production processes was taken primarily from the Encyclopedia of Chemical Technology edited by Marks, et al., and published in 1978. This source, however, provides little or no information regarding the point-of-generation of the waste streams in question. Relevant point-of-generation data were obtained from public comments submitted by the industry, previous EPA reports (e.g., Overviews of Solid Waste Generation, Management, and Chemical Characteristics for various processing sectors prepared for EPA by PEI Associates and Radian Corporation), and Bureau of Mines publications (e.g., Mineral Facts and Problems, 1985 Ed.).

Information describing the use of mineral products was taken primarily from Bureau of Mines publications (i.e., Mineral Facts and Problems, 1985 Ed., Mineral Commodity Summaries, 1989 Ed., and Minerals Yearbook, 1987 Ed.). Additional information was obtained from public comments and trade publications.

EPA's understanding of mineral production processes and product uses has also been significantly enriched as a result of the field sampling and site visits described above. In a number of instances, subtle differences between facilities in a given commodity sector with respect to the production processes employed and product types produced (hence, markets served) have been noted. The knowledge gained thereby has been incorporated into the Agency's analyses and throughout the sector-specific discussions that follow this chapter, as appropriate.

Waste Generation and Management

In order to describe each facility's waste generation and to prepare the analyses of risk and cost and economic impacts, and potential for alternative utilization, the Agency needed to accurately assess the volume of waste generated at each facility. In estimating waste generation rates for the twenty waste streams, EPA primarily used data from its 1989 National Survey of Solid Wastes from Mineral Processing Facilities (SWMPF Survey), and information supplied by industry experts at the U.S. Bureau of Mines. In some cases, EPA utilized data submitted in public comments by facility operators and trade associations.

EPA also compiled and tabulated facility-specific data on the general physical characteristics and chemical composition of the twenty wastes, and on the practices employed to manage them, again based primarily on the SWMPF Survey data, and has used these data in subsequent analyses. Such data also came from EPA sampling activities, site visits, and other data collection requests (e.g., RCRA §3007 requests, damage case data collection). Facility-specific details regarding waste management include type(s) of management units and volumes managed in each unit, pollution controls in place for each unit (e.g., liner type and number, presence of leachate collection systems, run-on/run-off and wind dispersal controls), and whether or not ground water, surface water, and/or air is currently monitored. EPA also collected and evaluated information on waste treatment, including types of reagents used and management techniques applied to treatment sludges and effluent(s).

Information submitted by industry in response to the SWMPF Survey was supplemented and critically evaluated against data obtained from published sources, information collected as part of the damage case development process, and EPA observations made during waste sampling and other site visits. The descriptions of waste management practices provided in this report reflect EPA's synthesis of the information obtained during all of these information collection activities.

Relationship of Waste Generation and Management Practice Information to other Parts of the Report

Waste characteristics, generation, and management data have been collected and analyzed for two primary purposes: 1) to understand the industry (i.e. RCRA §8002(p)(1-2) require EPA to analyze "the source and volumes of such materials generated per year; (and) the present disposal and utilization practices"), and 2) to evaluate risk, alternative management practices (including utilization), and costs and impacts of such alternative management practices (RCRA §8002(p)(3) and (5-6)).

Risk Assessment

Waste generation rates, physical and chemical characteristics, and management practices are three major inputs to the analysis of the risk posed to human health and the environment by the wastes under study in this report. The quantity of waste managed is important in evaluating the magnitude and duration of environmental impacts. Waste characteristics, in part, determine whether the waste has the potential to release harmful constituents to the environment. Knowledge of waste management practices, including controls (e.g., caps, liners) for the protection of the various media of environmental transport (e.g., air, surface water, ground water) will, in part, determine the ability of any harmful constituents to be transported to potential human or biotic receptors.

Evaluation of Management Alternatives and Potential Utilization

Waste characteristics and the outcome of the risk and damage case analyses determine the need for and types of alternative management practices that EPA might consider. In addition, the technical feasibility of management alternatives and the economic feasibility of utilization alternatives are directly affected by waste generation rates.

Cost and Economic Impacts

The volume and management practice data are key inputs into the evaluation of the costs of both existing and alternative waste management practices. Cost estimation equations are driven primarily by the volume of the waste managed and include a logarithmic component to simulate the effects of economies of scale. Alternative waste management practices involve compliance with additional design specifications that must be modeled by the cost estimation procedure. Waste characteristics are important in that they are a factor in determining what type of management alternatives may be required for the protection of human health and the environment.

2.2.2 Potential and Documented Danger to Human Health and the Environment

Potential Danger to Human Health and the Environment

EPA conducted a facility-specific analysis of the risks associated with each of the 20 mineral processing wastes. The Agency collected information on the major factors that influence risks from the management of the special wastes at each of the 91 facilities that generate the wastes, and analyzed this information to develop conclusions on the potential for toxic constituents to be released from the waste and cause human health and environmental impacts.

EPA used a three step approach in this risk assessment, as illustrated in Exhibit 2-1:

- First, the Agency assessed the intrinsic hazard of the wastes by comparing the concentrations of toxic or radioactive constituents in the wastes and in the leachate extracts from the wastes to screening criteria.[1] This step was used to determine which constituents of the special wastes do not pose a risk to human health or the environment, even under very conservative (i.e., protective) release and exposure assumptions. If a waste contained constituents in concentrations that exceeded the screening criteria, then the Agency further evaluated (in the next step of the analysis) the potential for the waste to pose risk. A detailed discussion of the screening criteria and their derivation is provided later in this chapter and in Appendix C-1 to this report.
- Second, EPA assessed the potential for constituents of potential concern from the wastes to cause damage at the 91 facilities that generate the special wastes by evaluating the practices currently used to manage the wastes and the environmental settings in which the wastes are managed. Using facility-specific information about special waste management and environmental setting, EPA evaluated the potential for toxic or radioactive constituents that exceed the screening criteria to be released from waste management units and to migrate to potential exposure points.
- Third, EPA performed quantitative modeling to estimate the human health and environmental risks associated with existing waste management practices. In this portion of the analysis, EPA estimated risks for only those wastes, facilities, and potential release and exposure pathways that appeared to pose a hazard based on the findings from the previous steps of the risk assessment.

The Agency used each step as a means of narrowing the scope of the analysis to those wastes and facilities that pose the greatest potential risk. The evaluation of the intrinsic hazards of the wastes (Step 1) was used to eliminate from further consideration any toxic or radioactive constituents that are not present in concentrations of concern (based on conservative exposure assumptions). Evaluation of release, transport, and exposure potential (Step 2) was used to identify potential exposure pathways and to allow a categorization of the risk potential (i.e., high, medium, low) for all facilities generating each waste. Risk modeling (Step 3)

[1] The focus of the screening criteria is on toxicity and radioactivity, in addition to a simple determination of corrosivity. EPA has sufficient knowledge of the characteristics of the 20 special mineral processing wastes to conclude that none are ignitable or reactive.

Exhibit 2-1
Overview of Risk Assessment Methodology

was limited initially to facilities with the highest risk potential. Modeling of additional facilities was performed only if estimated risks were significant for the facilities with high risk potential.

In all steps of the analysis, EPA focused on human health and environmental risks associated with chronic exposures to potential releases of waste constituents to ground water, surface water, and air. While large, short-term (acute) exposures to these wastes may occur, this analysis is restricted to chronic exposures, for two reasons. First, given the relatively low hazard of these wastes (as documented by application of the low hazard criterion used in the Agency's recent rulemakings on these special wastes), EPA concluded that the potential for adverse effects from large, short-term exposures to these wastes is very limited (i.e., acute risk generally occurs at levels of exposure that are not likely given the low hazard of these wastes). Second, most of the toxicological data and exposure assumptions available for the purpose of risk assessment are based on chronic exposures. When possible, the Agency did evaluate the potential for large episodic releases of waste constituents (e.g., from storm or flood events) to endanger human health or the environment.

To analyze risks to human health, the Agency evaluated the cancer and non-cancer risks to maximally exposed individuals at each site. A "maximally exposed individual" is designated for each exposure pathway as the person at greatest risk from exposures to toxic constituents released into the environment. EPA did not assess population risks explicitly, but data on potentially exposed populations were considered in drawing conclusions about the overall risks associated with the current management of special wastes.

To analyze environmental risks, the Agency evaluated the potential for contaminants to migrate from the waste and adversely affect aquatic organisms. EPA did not attempt to evaluate potential impacts on terrestrial ecosystems because little information is available on the exposure of terrestrial organisms to waste constituents and toxicological data relevant to terrestrial ecosystems are limited. In addition to risks to human health and aquatic life, EPA also evaluated the potential for existing waste management practices to cause air and water contamination, irrespective of the potential for humans or ecological receptors to be exposed to the contamination.

Data Used in the Risk Assessment

To conduct the risk assessment as outlined above, EPA collected and evaluated data on the factors that influence risks at each facility that generates the wastes. EPA's data collection focused on three major categories of information:

- waste composition data,
- waste management practice data, and
- environmental setting data.

Waste Composition Data. The Agency relied on three primary sources for data on the chemical composition of each mineral processing waste. First, the Agency used data collected by OSW during sampling visits in 1989. OSW sampled the wastes at a total of 27 of the 91 affected facilities. The Agency sampled at least two facilities for each waste stream unless the waste is generated by only a single facility. Second, the Agency used data submitted by industry in response to an EPA request for data under §3007 of RCRA. A total of 64 facilities submitted useable waste composition data in response to this request, and all wastes of interest are represented in these data except magnesium process wastewater and treated roast/leach ore residue from sodium dichromate production. Third, EPA used waste composition data collected by ORD during sampling visits in 1984 and 1986, and data collected by OSW during sampling visits in 1985. Data collected by ORD are available for five wastes studied in this report: lead slag, copper slag, phosphoric acid process wastewater, phosphogypsum, and elemental phosphorus slag. Data collected by OSW in 1985 are for red and brown muds from alumina production. All together, these three sources provide data on the concentration of some 20 metals, 3 radionuclides, gross alpha and beta radiation, and a number of other constituents (including several ions and, in the case of the coal gasification wastes, numerous organic compounds). A more detailed discussion on the amount and nature of data considered for each special waste is provided in the sector-specific chapters of this report.

Although data on waste composition were provided in responses to the 1989 National Survey of Solid Wastes from Mineral Processing Facilities, the Agency did not use these data in the risk assessment for two reasons. First, the survey responses often provide information on only the primary components of the waste and do not characterize the waste's trace constituents, which are often important from a risk assessment standpoint. Second, the survey responses provide only single, "typical" concentrations and do not indicate the number of samples upon which those typical values are based, the time frame over which the samples were collected, the sampling locations, or the distribution of individual sample results. As a result, the typical concentrations reported in the survey could not be integrated with sampling data from the other sources outlined above to develop overall statistics on the frequency and magnitude with which constituent concentrations exceed the screening criteria.

Waste Management Practice Data. For data on current waste management practices, EPA relied primarily on information provided in response to the 1989 National Survey of Solid Wastes from Mineral Processing Facilities and information collected from visits to a number of the facilities studied for this report. The survey responses, prepared by facility personnel, include information on the waste volumes generated and managed at each plant, the quantity of waste managed in individual units, and the design characteristics of each management unit. Reports from visits to mineral processing facilities for sampling or other information collection purposes were used to supplement the data provided in the survey responses. These reports contain additional information on the design of waste management units as well as observations about the physical form of the wastes and photographs of the waste management units.

Environmental Setting Data. EPA relied on a number of sources of data on the environmental setting of the 91 facilities that generate the special wastes covered by this study. The environmental setting data collected for the risk assessment include information on climatological conditions, factors affecting atmospheric dispersion, hydrogeological parameters, surface water characteristics, population distributions, and proximity to sensitive environments (i.e., environments that are vulnerable or have a high resource value, such as National Parks or Forests). These data were collected from a number of sources, including EPA data compilations (e.g., Graphical Exposure Modeling System [GEMS] and Federal Reporting Data System [FRDS]); responses to the 1989 National Survey of Solid Wastes from Mineral Processing Facilities; U.S. Geological Survey (USGS) topographic maps and hydrologic data files; the National Water Well Association's DRASTIC ground-water vulnerability system; soil surveys developed by the Soil Conservation Service of the U.S. Department of Agriculture, and U.S. Department of the Interior (DOI) maps of the critical habitat of endangered species (50 CFR 17.95).

Evaluation of Intrinsic Hazard of Wastes

As the first step of its risk assessment, EPA screened the waste composition data described above to determine if the special wastes contain toxic or radioactive constituents at concentrations that could pose risks to human health, aquatic organisms, and air and water resource quality. The objective of this screening procedure was twofold: (1) to narrow the focus of the risk assessment by eliminating from further evaluation those constituents that are unlikely to endanger human health or the environment; and (2) to identify any constituents that warrant further evaluation (i.e., constituents of potential concern). To determine constituents of potential concern, EPA compared the constituent concentrations measured in samples of mineral processing wastes to screening criteria, and evaluated the persistence and mobility of each constituent in various environmental media.

Comparison of Chemical Concentrations to Screening Criteria. EPA developed a set of constituent-specific screening criteria that reflect the potential for hazards to human health, aquatic organisms, and air and water quality based on conservative release, transport, and exposure assumptions. These screening criteria represent constituent concentrations in waste or leachate samples that could endanger human health, aquatic life, or water or air quality if the waste is released to the environment. Because this step is intended to evaluate the intrinsic hazard of the wastes, the screening criteria are based on exposure assumptions that are likely to overstate the risks posed by the management of the wastes at the facilities of concern. Consequently, this step identifies all constituents that warrant further evaluation as potential constituents of concern, and only those constituents that do not contribute to

the intrinsic hazard of the waste are removed from further consideration. The underlying rationale for the screening criteria developed for this analysis is summarized in Exhibit 2-2, and the actual screening values are listed in Exhibit 2-3 (the benchmarks upon which these screening criteria were developed are provided in Appendix C-1 of this report). All screening criteria developed for chromium assume that this metal is present in its more toxic hexavalent form.

As shown in Exhibits 2-2 and 2-3, the screening criteria can be divided into two main categories: (1) criteria to compare to constituent concentrations measured in solid samples, and (2) criteria to compare to constituent concentrations measured in liquid and leachate extract samples, or in extract samples from solids. The screening criteria compared to concentrations in solid samples include criteria that reflect the potential for hazards to human health via inhalation, incidental soil ingestion, and multiple radiation exposure pathways, as well as a criterion that reflects the potential for air quality degradation.

- Human Health/Inhalation Screening Criteria. To develop these criteria, the Agency used inhalation cancer slope factors from EPA's Integrated Risk Information System (IRIS) to derive an airborne concentration of carcinogens that corresponds to a lifetime cancer risk of 1×10^{-5}. Similarly, the Agency used inhalation reference doses from IRIS for non-carcinogens to derive an airborne concentration that, if inhaled, would result in the reference dose. To convert these airborne concentrations (in units of ug/m^3) to solid concentrations (in units of ug/g) the Agency made two conservative (i.e., protective) assumptions: (1) the airborne concentration of respirable particles equals the National Ambient Air Quality Standard (NAAQS) for respirable particulate matter (50 ug/m^3), and (2) the constituent concentration in the airborne respirable particles equals the constituent concentration in the waste. These assumptions probably overestimate the extent to which respirable particles are blown into the air from the special wastes studied in this report because many of the wastes are in the form of large particles (ranging in size all the way up to boulders) or form surface crusts that are not susceptible to dust generation.

- Human Health/Soil Ingestion Screening Criteria. To develop these screening criteria, EPA used oral cancer slope factors and non-cancer reference doses from IRIS, along with an Agency guideline on soil ingestion rates,[2] to derive a waste concentration that could cause health risks if small quantities of the waste are incidentally ingested on a routine basis. These screening criteria are based on the assumption that public access to the wastes is not restricted and, for example, children are allowed to play on, or in the vicinity of, special waste management units.

- Human Health/Radiation Exposure Screening Criteria. To screen for potential radiation hazards, the Agency used EPA's standard in 40 CFR 192 for the clean up of soil contaminated with radium-226 at uranium mill tailings sites (5 pCi/g). This standard is designed to limit the risk from the inhalation of radon decay products in houses built on contaminated land and to limit gamma radiation exposures of people using contaminated land. The Agency also used the Nuclear Regulatory Commission's (NRC's) guidelines for acceptable concentrations of uranium-238 and thorium-232 in soil that can be released for unrestricted use.[3] As stated in these standards and

[2] Memorandum from J. Winston Porter, Assistant Administrator for EPA's Office of Solid Waste and Emergency Response, to EPA Regional Administrators, concerning Interim Final Guidance for Soil Ingestion Rates, OSWER Directive 9850.4, January 27, 1989.

[3] NRC, 1981. Disposal or Onsite Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) from Past Operations, SECY 81-576, October 5.

Exhibit 2-2
Overview of Constituents of Concern Screening Criteria

Sample Test Type	Type of Hazard That is Evaluated	Assumed Release/ Exposure Pathway That Underlies Screening Criteria	Screening Criteria
Solid Samples	Human Health Risk	Inhalation of airborne particulates	Inhalation toxicity criteria for cancer and noncancer effects, assuming that dust is blown into the air in a concentration that equals the National Ambient Air Quality Standard (NAAQS) for particulate matter
		Incidental ingestion of waste and contaminated soil	Oral toxicity criteria for cancer and noncancer effects, assuming that access to a waste is not restricted and children incidentally ingest contaminated solids
		Radiation exposure to contaminated land	EPA's radium-226 cleanup standard for uranium mill tailings sites; Nuclear Regulatory Commission guidelines on uranium-238 and thorium-232 concentrations in soil that can be released for unrestricted use
	Air Quality Degradation	Airborne release of lead as windblown dust	Lead concentration in waste that could result in an exceedance of the NAAQS for lead if dust is blown into the air in a concentration that equals that NAAQS for particulate matter
Liquid Samples (including leachate test samples)	Human Health Risk	Ingestion of contaminated ground water	10 times oral toxicity criteria for cancer and noncancer effects, assuming ingestion of 2 liters of contaminated water per day for 70 years
	Aquatic Ecological Risk	Release of waste constituents to surface water and exposure of aquatic organisms	100 times Ambient Water Quality Criteria (AWQC)
	Surface and Ground-Water Quality Degradation	Release of waste constituents to surface or ground water	10 times drinking water maximum contaminant levels when available; otherwise, the lower of: (1) 10 times the taste and odor thresholds, livestock watering guidelines, or irrigation guidelines; or (2) 100 times the AWQC for fish ingestion

guidelines, the radiation criteria are based on the assumption that public access to the waste is unrestricted.

- Air Resource Damage Screening Criterion. To screen for the potential for mineral processing waste solids to degrade ambient air quality, EPA used the NAAQS for particulate matter and the NAAQS for lead to derive a lead concentration in solid waste (there are no NAAQSs for any other metals that could exist in mineral processing wastes). Exceedance of this screening criterion indicates the potential for an exceedance of the lead standard if a sufficient amount of a waste is blown into the air as dust.

The screening criteria used to evaluate constituent concentrations in liquid samples (either total liquid or leach test analyses) include criteria that reflect the potential for hazards to human health via water ingestion, adverse effects to aquatic organisms, and degradation of surface and ground-water quality. In developing these criteria, the Agency has assumed a 10-fold dilution of liquid wastes or leachate into ground water and a 100-fold dilution in surface water. The Agency selected these conservative (i.e., small) dilution factors because the screening criteria are designed to evaluate the intrinsic hazard of the wastes, irrespective

Exhibit 2-3
Screening Criteria Values[a]

Constituent	Screening Criteria for Solid Samples			Screening Criteria for Liquid/Leach Test Samples		
	Inhalation (µg/g)	Incidental Ingestion (µg/g)	Radiation (pCi/g)	Human Health (Ingestion) (µg/L)	Aquatic Ecological (µg/L)	Water Resource Damage (µg/L)
Acetonitrile	--	4,200	--	2,100	--	--
Aluminum	--[b]	--	--	--	8,700	50,000
Antimony	--	280	--	140	160,000	4,500,000
Arsenic	14	4	--	2	1,300	500
Barium	7,000	35,000	--	18,000	5,000,000	10,000
Beryllium	84	3,500	--	1,800	530	120
Boron	--	63,000	--	32,000	500,000	7,500
Cadmium	115	350	--	180	110	100
Chloride	--	--	--	--	23,000,000	2,500,000
Chromium(VI)	17	3,500	--	1,800	1,100	500
Cobalt	--	--	--	--	--	500
Copper	--	25,900	--	13,000	290	13,000
Fluoride	--	42,000	--	21,000	--	40,000
Gross alpha	--	--	--	--	--	150 pCi/L
Gross beta	--	--	--	--	--	500 pCi/L
Iron	--	--	--	--	100,000	3,000
Lead	30,000[c]	420	--	210	320	50
Magnesium	--	--	--	--	--[d]	--
Manganese	21,000	140,000	--	70,000	100,000	500
Mercury	--	210	--	100	1.2	20
Molybdenum	--	--	--	--	--	100
Nickel	833	14,000	--	7,000	830	2,000
Nitrate	--	700,000	--	350,000	9,000,000	100,000
Nitrite	--	70,000	--	35,000	6,000	10,000
pH	--	--	--	--	6.5-9	6.5-8-5
Phenol	--	420,000	--	210,000	256,000	1
Phosphorus	--	--	--	--	10	--
Phosphate (Total)	--	--	--	--	2,500	--
Radium-226	134 pCi/g	--	5	16 pCi/L	--	50 pCi/L
Selenium	80	2,100	--	1,100	500	100
Silver	--	2,100	--	1,100	12	500
Sulfate	--	--	--	--	--[d]	2,500,000
Suspended Solids	--	--	--	--	2,500,000	--
Thallium	--	49	--	25	4,000	4,600
Thorium-232	13 pCi/g	--	10	91 pCi/L	--	--
Uranium-238	17 pCi/g	--	10	15 pCi/L	--	--
Vanadium	--	4,900	--	2,500	128,000	1,000
Zinc	--	140,000	--	70,000	8,600	50,000

[a] See text for an explanation of the derivation of these screening criteria and Appendix C-1 of this report for a presentation of the benchmarks upon which these screening criteria are based. Some of these screening criteria, especially the incidental ingestion criteria, are very high values (e.g., the incidental ingestion criterion for nitrate is more concentrated than normal fertilizer). However, they were derived using the methods described in the text and represent concentrations that could be harmful under the assumed exposure scenarios.

[b] No screening criterion used because of lack of applicable benchmarks.

[c] No inhalation RfD for lead is provided in IRIS. This value is the screening criterion used to analyze the potential for "air quality degradation."

(d) An aquatic ecological screening criterion of 5,000,000 ug/L Total Dissolved Solids was used to evaluate the combined concentration of magnesium and sulfate.

of the settings in which they are currently managed. The factors of 10 and 100 for ground water and surface water, respectively, reflect a minimal level of dilution expected to occur as constituents are released to receiving waters in which exposures or resource damage could occur. Consequently, the resulting screening criteria eliminate from further evaluation only those constituents that are not expected to pose a risk, even in the event that waste contaminant concentrations are not extensively diluted before reaching exposure points.

- Human Health/Water Ingestion Screening Criteria. To develop these criteria, EPA used oral cancer slope factors from IRIS to derive a liquid concentration of carcinogens that corresponds to a cancer risk of 1×10^{-5}. Similarly, the Agency used oral reference doses from IRIS for non-carcinogens to derive a liquid concentration that, if ingested, would result in the reference dose. The Agency then multiplied these concentrations by a factor of 10 to derive a liquid waste or leachate concentration that accounts for possible dilution that may occur if the waste is released to ground water.

- Aquatic Ecological Risk Screening Criteria. To develop these screening criteria, EPA compiled available Ambient Water Quality Criteria (AWQC) for both chronic and acute exposures of both freshwater and saltwater organisms. The Agency selected the lowest available AWQC for a given constituent and multiplied it by a factor of 100 to derive a liquid waste or leachate concentration that accounts for possible dilution that may occur if the waste is released to surface water.

- Water Resource Damage Screening Criteria. To derive these criteria, EPA assembled the following benchmarks for each constituent detected in the mineral processing waste samples: primary and secondary Maximum Contaminant Levels (MCLs) for drinking water; taste and odor thresholds; National Academy of Science (NAS) recommendations for livestock watering and irrigation; and the AWQC for fish ingestion. Whenever an MCL was available, EPA used that value multiplied by a factor of 10 to derive a liquid waste or leachate concentration that accounts for possible dilution that may occur if the waste is released to ground water. When an MCL was not available, EPA selected the next lowest value and multiplied that value by either a factor of 10 or a factor of 100 to derive a liquid waste or leachate concentration that accounts for possible dilution if the waste is released to ground water (factor of 10) or surface water (factor of 100).

EPA pooled all the available data for a given waste stream and compared measured constituent concentrations in solid and liquid samples to the relevant screening criteria. For this evaluation, the Agency considered only concentrations that were detected. Analyses for which a given constituent was not detected were not used to evaluate the hazard posed by the constituent. If a constituent concentration in any sample of a waste from any facility exceeded one of the screening criteria, regardless of the magnitude of the exceedance or the frequency of exceedances for the data as a whole, that constituent was considered a potential constituent of concern for the waste (for purposes of this conservative screening analysis).

The data used in the risk assessment include leachate concentrations from a number of leach tests, including the Extraction Procedure (EP), the Toxicity Characteristic Leaching Procedure (TCLP), and the Synthetic Precipitation Leaching Procedure (SPLP).[4] Because most of the available data are from EP leach tests, the Agency relied most heavily on these data in evaluating potential constituents of concern in leachate.[5] The Agency recognizes that the EP leachate test is a relatively conservative approach for estimating the concentrations of some metals in leachate generated from the mineral processing wastes as they are currently managed. To determine the extent to which EP leachate data differ from SPLP leachate data, the Agency evaluated the differences between SPLP and EP leachate concentrations for the special wastes. This evaluation demonstrated that although the two tests provide similar results for many constituents in most wastes, some constituents (e.g., iron, lead, zinc, aluminum, cadmium, copper, nickel) are commonly present in higher concentrations in EP leachate than in SPLP leachate. A smaller number of constituents (e.g., arsenic, vanadium,

[4] EPA Methods 1310, 1311, and 1312, respectively.

[5] The recently promulgated (March 29, 1990) Toxicity Characteristic (TC) will replace the EP Toxicity characteristic as of its effective date. Because, however, the wastes considered in this report are, for the most part, unlikely to contain the organic constituents that were added by the TC, and because the regulatory levels for metals employed in these two methods are identical, the Agency believes that any conclusions regarding the inherent toxicity of the wastes considered in this report are likely to remain valid once the TC becomes effective.

molybdenum, barium) are commonly found in higher concentrations in SPLP leachate than EP leachate. Given the conservative nature of this screen and the preponderance of EP leachate data, the Agency believes that it is appropriate to use EP leachate data in this evaluation of mineral processing wastes.

EPA acknowledges that this use of the EP leachate data differs from the approach used in the Agency's recent rulemakings on mineral processing wastes (reinterpreting the scope of the Mining Waste Exclusion), but believes that there are sound reasons for adopting this approach. In the rulemakings, EPA collected and used limited SPLP data in order to establish which wastes qualify as "low hazard" and are thus eligible for detailed study in this report (i.e., use of the SPLP data was a reasonable approach for selecting the wastes to be studied, because wastes that exhibit hazardous characteristics under the SPLP test are clearly not low hazard). For purposes of actually conducting a risk assessment, however, relying primarily on the EP leachate data is a reasonable, though more conservative (i.e., protective) approach.

Evaluation of Constituent Persistence and Mobility. Even though a constituent may exist in a waste in potentially harmful concentrations, the constituent may pose little or no risk if it rapidly degrades in the environment or if it is unable to migrate away from the waste management unit. Therefore, for each potential constituent of concern identified based on its concentration relative to screening criteria, EPA evaluated the extent to which the constituent can persist and migrate in the environment.

Because most of the constituents that are present in mineral processing wastes in elevated concentrations are metals that do not degrade in the environment, the evaluation of persistence was largely a moot exercise. However, for the organic constituents detected in elevated concentrations in a few of the wastes, EPA evaluated the constituents' persistence by considering their degradation rates in ground water, surface water, and air.

To evaluate constituent mobility, the Agency considered the tendency for each constituent to bind to soil when present in ground water and the potential for organic constituents to be released to the air by volatilization. For the analysis of ground-water mobility, EPA examined the sorption coefficient (K_d, a measure of the degree to which contaminants bind to soil) for each inorganic constituent and assumed that inorganic constituents with K_d values less than 20 ml/g are relatively mobile in ground water, while inorganics with K_d values greater than 20 ml/g are relatively immobile in ground water. This assumption is based on the results of previous modeling exercises that demonstrated that constituents with K_d's greater than 20 ml/g often migrate so slowly in ground water that they do not reach distances of interest within 200 years (i.e., their potential to endanger human health and damage water quality over typical modeling horizons is extremely limited).[6] For organics that were detected, EPA evaluated each constituent's Henry's Law constant, a parameter that indicates the degree to which a constituent is likely to be released to air by volatilization from aqueous solution.

Conclusions from Intrinsic Hazard Evaluation. Given the conservative (i.e., protective) nature of the screening criteria, waste constituents that are present in concentrations below the screening criteria are not likely to pose a risk to human health or the environment. On the other hand, exceedances of the screening criteria should not, in isolation, be interpreted as proof of hazard. Therefore, if a constituent in any sample of a waste exceeded a screening criterion, and if the constituent was considered persistent and mobile in the environment, EPA concluded that risk posed by the waste should be evaluated further. EPA then proceeded to the next step of the risk assessment to evaluate the potential for constituents of concern to be released into the environment and migrate to receptor locations, by considering the existing waste management practices and environmental settings of the facilities that generate the waste.

Evaluation of Release, Transport, and Exposure Potential

In this second step of the risk assessment, the Agency evaluated the potential for the waste to pose risks to human health and the environment based on its current management at the 91 mineral processing facilities. In particular, EPA assessed facility-specific information on a number of factors that relate to the potential for the waste to be released

[6] U.S. EPA. 1987. Onshore Oil and Gas Exploration, Development, and Production: Human Health and Environmental Risk Assessment (Technical Support Document). Office of Solid Waste, December.

into ground water, surface water, and air, and subsequently transported to locations where humans or aquatic organisms could be exposed.

The Agency assessed ground-water release, transport, and exposure potential by evaluating the waste leachability, management unit characteristics (e.g., presence of engineered controls), hydrogeological setting characteristics (e.g., net recharge, depth to aquifer, nature of subsurface material), and distance to potential exposure points. To assess surface water release, transport, and exposure potential, EPA considered the distance to the nearest downhill surface water, the likelihood of overland releases of waste from the unit in stormwater run-off, the likelihood that contaminated ground water could discharge to surface waters, the type and size of the nearby surface water, and the distance to potential exposure points. Similarly, air pathway release, transport, and exposure potential was assessed by evaluating the characteristics of the management unit related to the potential for wind erosion and suspension of dust from vehicular disturbances, meteorological conditions, and the proximity of the unit to potential exposure points. When possible, EPA used information developed from the damage case analyses to support the assessments of release, transport, and exposure potential for all three pathways. For the phosphoric acid and elemental phosphorus sectors, EPA also relied upon previous Agency analyses[7,8] of radiation risks to supplement the data collected specifically for the present assessment of risk. Based on the findings of this effort, EPA developed qualitative conclusions on the potential for the wastes to cause impacts by each of these release and exposure pathways.

The scope of this portion of the analysis was limited in several important ways. EPA evaluated only the baseline hazards of the wastes as they were generated and managed in 1988 at the 91 facilities of interest. Moreover, the Agency did not assess: (1) risks of off-site use or disposal of the few wastes that are ever managed off-site; (2) risks associated with potential future changes in waste management practices or population patterns; or (3) risks of alternative management practices. EPA is unable to extend its assessment of risk along any of these three dimensions because of insufficient data. However, EPA does evaluate the hazards of off-site use or disposal in the context of certain damage cases, as well as the hazards of alternative management practices in the waste-specific discussions of management alternatives and potential utilization.

Risk Modeling

EPA's risk assessment methodology has been designed to develop and present the key determinants of risk in a form that is objective and readily accessible to interested parties. Risk is a function of (1) the physical and chemical characteristics of a particular waste (particle size, constituent concentrations), (2) the manner in which the waste is managed, and (3) site-specific environmental conditions (e.g., net recharge) and proximity to potential receptors (e.g., surface water, drinking water wells, wetlands).

Only if the evaluation of these three factors in combination indicates that chemical/radiological contaminants could reach potential receptors in potentially harmful concentrations is there a need to quantify the magnitude of any such exposures and their associated risks. Risk modeling is a valuable analytical tool that the Agency has employed on an as-needed basis to resolve the issue of potential risk in cases where the result of evaluating the three factors is either ambiguous or indicates a potentially serious risk that requires more detailed study.

In addition, results obtained by assessing risk-related factors are compared with the findings of the damage case collection effort that is described below, as a final "reality check." The data that EPA has collected to conduct the risk assessment exercise is incomplete in some cases (waste constituent data) and of limited precision in others (e.g., aquifer characteristics). Consequently, review of damage case information provides a valuable means of filling information gaps and developing a more complete view of potential risk. At the same time, however, documented damages associated with management of a given waste do not necessarily prove that chronic human health or environmental risk is significant. In some instances, for example, damages may have occurred at sites that are no longer active (i.e., may have different environmental settings), or may reflect the effects of unusual circumstances (e.g., severe storms). Accordingly, EPA's evaluation of damage case information in the context of establishing the need for risk

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[7] U.S. EPA, 1989, Risk Assessments: Environmental Impact Statement for NESHAPS: Radionuclides, Volume 2 (Background Information Document), Office of Radiation Programs, September 1989.

[8] U.S. EPA, 1990, Idaho Radionuclide Study, Office of Research and Development, Las Vegas Facility, Las Vegas, NV, April 1990.

modeling accounts for whether the documented damages reflect actual site conditions and whether the types of observed impacts can be quantified by the risk model.

If, at the end of this multi-stage process, EPA finds no significant risk potential and no documented cases of environmental damage associated with a particular special waste, then the Agency believes that (1) the relevant RCRA §8002(p) study factors have been addressed adequately, and (2) further analysis in the form of risk modeling would not influence the results of the Agency's analysis or EPA's conclusions regarding the adequacy of current waste management controls.

Otherwise, EPA conducted further analysis of risk using more sophisticated quantitative methods. The Agency identified the wastes, facilities, and potential release/exposure pathways that appear to pose relatively high risks, then used a computer model to quantitatively estimate risks for those wastes, facilities, and pathways with the highest risk potential. EPA estimated risks on a facility-specific basis using the data and information sources outlined above.

EPA used the model "Multimedia Soils" (MMSOILS) to estimate the risks posed by mineral processing wastes. MMSOILS was originally developed for EPA's Office of Health and Environmental Assessment[9] to estimate the human exposure and health risk associated with contaminated soils at hazardous waste sites. The model has undergone extensive peer review by several offices of EPA and members of the academic community. For the purpose of this study, OSW revised MMSOILS to include algorithms for predicting contaminant releases from various waste management units, such as waste piles, landfills, and surface impoundments. Appendix C-2 of this report provides a more detailed summary of MMSOILS and how it was applied in this analysis.

The Agency used MMSOILS to estimate the following risk measures:

- Cancer and chronic non-cancer risks for maximally exposed individuals via the inhalation and water ingestion pathways, assuming an individual breathed contaminated air or ingested contaminated water over an entire lifetime (assumed to be 70 years). The cancer risk estimates represent the estimated incremental probability of occurrence of cancer in an exposed individual, over that individual's lifetime. The measure used for non-cancer risk was the ratio of the maximum estimated chemical dose to the dose of the chemical at which health effects begin to occur.
- Risks to aquatic organisms caused by chronic exposures to surface water contamination. The risk measure used for aquatic ecological risk was the ratio of the maximum estimated surface water concentration of a chemical to the chronic AWQC for that chemical.
- Potential contamination of air and water in excess of resource damage criteria. The measure developed for potential air quality degradation was the ratio of maximum estimated concentrations of airborne lead to the NAAQS for lead. The measures developed for potential water quality degradation were the ratios of contaminant concentrations at various downgradient/downstream distances to non-health related benchmarks.

To estimate each of these risk measures, EPA modeled the wastes using median constituent concentrations, including median concentrations in waste leachate as measured using the EP leach test. As discussed above, EPA believes that use of the EP leachate data is a reasonably conservative approach. The Agency believes it was appropriate to use median concentrations because the values used for all of the other model variables (including waste volume, management practice, and environmental setting parameters) were also typical or central values generally designed to yield "best estimates" of risk.

Finally, EPA considered only chronic, steady-state releases and a 200-year modeling period. Releases from units with liners or other engineered controls were assumed to begin several years after the units were first put into operation, and then to progressively increase in order to simulate gradual deterioration of the liners/controls after the units are closed. Otherwise, releases to the environment were assumed to occur at a constant rate because the readily available input data on environmental setting (e.g., annual precipitation, stream flow, annual average wind speed) are reported as steady-state parameters. The Agency considered a 200-year modeling period because previous EPA risk

[9] ICF Technology, Inc. 1988. Methodology for Estimating Multimedia Exposures to Soil Contamination (Draft). Prepared for U.S. EPA Exposure Assessment Group, Office of Health and Environmental Assessment, Office of Research and Development, December 28.

modeling studies have indicated that this length of time is adequate to determine whether model results will indicate potential risk, i.e., extending the modeling period is unlikely to influence the results of the risk modeling exercise.

Documented Cases of Danger to Human Health or the Environment

Section 8002(p)(4) of RCRA requires that EPA's study of mineral processing wastes examine "documented cases in which danger to human health or the environment has been proved." In order to address this requirement, EPA defined danger to human health and the environment in the following way. First, danger to human health includes both acute and chronic effects (e.g., exceedances of drinking water standards, directly observed health effects such as elevated blood lead levels or loss of life) associated with management of mineral processing wastes. Second, danger to the environment includes: (1) impairment of natural resources (e.g., contamination of any current or potential source of drinking water); (2) ecological effects resulting in impairment of the structure or function of natural ecosystems and habitats; and (3) effects on wildlife resulting in impairment to terrestrial or aquatic fauna (e.g., reduction in species' diversity or density, impairment of reproduction).

This section describes the approach the Agency used to address the §8002(p)(4) requirement, including the "test of proof" used and the methods used to identify potential cases, collect documentation, and verify the accuracy and completeness of the resulting case studies. In addition, this section provides a discussion of the limitations associated with interpretation of the results obtained. Throughout the discussion, cases where danger has been proved are often referred to as damage cases.

"Test of Proof"

The statutory requirement is that EPA examine proved cases of danger to human health or the environment. As a result, EPA developed a "test of proof" to be used for determining if documentation available on a case proves that danger/damage has occurred. This "test of proof" contains three separate tests; a case that satisfies one or more of these tests is considered "proved." The tests are as follows:

1. Scientific investigation: Damages are found to exist as part of the findings of a scientific study. Such studies include both extensive formal investigations supporting litigation or a State enforcement action and the results of technical tests (such as monitoring of wells). Scientific studies must demonstrate that damages are significant in terms of impacts on human health or the environment. For example, information on contamination of a drinking water aquifer must indicate that contamination levels exceed drinking water standards.

2. Administrative ruling: Damages are found to exist through a formal administrative ruling, such as the conclusions of a site report by a field inspector, or through existence of an enforcement action that cited specific health or environmental damages.

3. Court decision: Damages are found to exist through the ruling of a court or through an out-of-court settlement.

Identification of Potential Damage Cases

EPA identified potential damage case sites by compiling a list of: (1) currently operating mineral processing facilities based on industry and government sources (e.g., Bureau of Mines); (2) mineral processing facilities on the National Priorities List under CERCLA; (3) and facilities identified in public comments on the rulemakings that established the wastes to be studied in this report. Additional facilities were added to this list during the information collection process described below when state or federal contacts indicated that additional facilities should be considered.

Information Collection

EPA used direct telephone and written contacts with state and federal agencies and individuals, as well as follow-ups to such contacts, to collect information on damage cases. Contacts were made with agencies in all of the

states with one or more of the facilities on the list of potential damage cases (developed as described above). Specific sources of information included:[10]

- Relevant state or local agencies, including state environmental regulatory agencies, mineral or mining regulatory agencies, state, regional, or local departments of health, and other agencies potentially knowledgeable about damages related to mineral processing operations;
- Professional or trade associations; and
- Public interest or citizen's groups.

The Agency then visited some of the states contacted to collect information about specific sites from state files. Selection of states to be visited was based on: (1) the type and complexity of site-specific information available in state files (based on the contacts with state personnel); (2) EPA's ability to obtain data of interest from state personnel without visiting the state; (3) the number and type of mineral processing facilities contained within the state; and (4) environmental factors unique to the state such as climate, geology, hydrology, and surface water features. Where feasible, information was collected by mail from state personnel.

During visits to state agencies, which were made during the period from November 1988 to February 1990, EPA reviewed documentation on sites on the list of potential damage cases, and collected documentation on those sites that appeared to meet one or more of the "tests of proof". Follow-up contacts were also made with agencies, groups, and individuals that the state files or personnel indicated might have additional relevant information. In addition, EPA also visited some of the mineral processing facilities in conjunction with visits to state agencies.

Damage Case Preparation and Review

Following completion of the data collection efforts, EPA prepared summaries of the information obtained for documented damage case sites. EPA then requested comments on the drafts of these summaries from the state and federal agency personnel who assisted in providing the information upon which the summaries were based. EPA specifically requested that the reviewers verify any interpretations of the available data and identify any available and relevant data that were not included. The comments that EPA received were used to prepare the final summaries,[11] which in turn provide the basis for the discussions of damage case findings that are included for each type of mineral processing waste covered by this report.

Limitations of the Damage Cases

The damage case findings that resulted from the process described above must be interpreted with care, for several reasons. First, mineral processing facilities are often co-located with mineral extraction and beneficiation (i.e., mining) operations; the mineral processing wastes covered by this report often are or have been co-managed with other wastes. As a result, it is sometimes difficult to determine if the documented damages were caused by stack emissions, direct discharges to surface water, etc., rather than mismanagement of mineral processing special wastes, or if waste management practices have been shown to have caused the observed damage, which type(s) of wastes (e.g., extraction or processing wastes) caused or contributed to the damage. The sites included in this report are those for which the available data indicate that the documented damages are attributable at least in part to mineral processing waste management.

Second, the extent to which the findings can be used to draw conclusions concerning the relative performance of waste management practices among states or across industry sectors is limited by variations in requirements and recordkeeping. Recordkeeping varies significantly among states. A few states have complete and up-to-date central enforcement or monitoring records on mineral processing waste management facilities within the state. Where states have such records, information on damages may be readily available. Thus, states that have environmental monitoring

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[10] Although many of the above sources were contacted in developing certain damage cases, the damage case gathering effort relied principally on information available through EPA regional offices and state and local regulatory agencies.

[11] Detailed information on the case study findings is provided in the public docket supporting this report.

information on mineral processing facilities may appear to contain more sites where damages have resulted from management of special wastes from mineral processing.

More often, enforcement and monitoring records are incomplete and/or distributed throughout regional offices within the state. Additionally, because mineral processing special wastes are not regulated under Subtitle C of RCRA, many states do not specifically regulate solid waste management at mineral processing facilities. Indeed, some states have passed legislation specifically forbidding the responsible state regulatory agency to impose regulations on solid waste management at mineral processing facilities that are more stringent than the federal regulations. As a result, monitoring and, thus, detection of problems at mineral processing facilities has occurred on a very limited basis, if at all, in some states. Therefore, while damages similar to those identified in states where mineral processing special waste management activities are monitored may exist in states that do not have an environmental monitoring or regulatory program for mineral processing special wastes, these damages could not be identified for this report.

Third, data collection efforts generally were focused on the central office of the appropriate state agencies. In some instances, information may have been available at a state regional office that was not available in the central office. Furthermore, researchers' ability to collect data at each office sometimes was limited by the ability of each state to provide staff time to assist in the research.

Finally, because environmental contamination resulting from waste disposal practices often takes many years to become evident, documented examples of danger that have resulted from particular waste disposal practices may reflect conditions that no longer exist. Specifically, process feedstocks, processing operations, waste characteristics, and/or waste management practices may have changed. As a result, damage cases associated with a waste do not necessarily demonstrate that practices used to manage waste that is currently being generated or regulations are in need of change. On the other hand, failure of a site to exhibit documented damages at present does not necessarily suggest that waste management has not or will not cause damage. The Agency believes, however, that information on dangers posed by past waste management practices is useful in demonstrating the potential for environmental and human health impacts when hazardous constituents are released.

2.2.3 Existing Federal and State Waste Management Controls

Federal Controls

EPA's objective in this analysis was to identify and evaluate the existing regulatory controls over the management of special mineral processing wastes that have been promulgated by agencies of the federal government, focusing on programs and requirements established by EPA. This characterization is necessary for two reasons. First, some states do not have EPA-approved programs for regulating discharges of contaminants to surface waters (NPDES) or regulating the management of hazardous wastes under Subtitle C of RCRA, or approved RCRA Subtitle D state solid waste management plans under 40 CFR Part 256. In these cases, federal EPA regulations take precedence. Second, the federal government has not delegated authority to the states for implementing some environmental protection statutes and regulations; thus, the federal government is responsible for their implementation.

The initial phase of the analysis examined the relevant statutes and regulations pertaining to hazardous waste, solid waste, air quality, and water quality as they might apply to the management of the mineral processing special wastes. The purpose of this review was to provide broad background information on the regulatory authorities available to the federal government that could affect the management of wastes generated from the extraction, beneficiation, and processing of ores and minerals.

The second phase of this analysis was to identify and evaluate any specific regulations, such as NESHAPs, effluent limitations, emission standards, MCLs, etc., that have been promulgated under authority of any of the major federal environmental statutes that pertain to any of the 20 special mineral processing wastes.

The final phase of this analysis involved contacting Regional EPA staff in those states that do not have federally approved programs for implementation of the major environmental statutes (e.g., RCRA, CWA), as well as relevant staff within other federal agencies and departments (e.g., Bureau of Land Management, U.S. Forest Service), and performing a detailed regulatory analysis of the implementation of all existing federal statutes and regulations that

pertain specifically to the management of the 20 special mineral processing wastes. Summaries of the results of this process have been incorporated into the commodity-specific chapters that follow. Detailed findings of EPA's analysis can be found in Appendix D-1 to this report.

Requirements in Selected States

EPA's goal in this analysis was to determine the current regulatory stance of states with regard to the mineral processing wastes generated by the 12 commodity sectors addressed in this report. The analysis serves more generally to help characterize current waste management and disposal practices taking place as a result of state regulation. This characterization is also, to a limited extent, used to establish a baseline for the analysis of costs and other impacts resulting from current and prospective regulatory requirements.

The first step in the analysis focused on reviewing material in a report on state-level regulation of mining and mineral processing wastes ("CDM report").[12] EPA examined the material in the CDM report that pertains to all 29 states containing one or more facilities considered in this report, and summarized portions of the hazardous waste, solid waste, air quality, and water quality statutes and regulations that are relevant to the current disposition of the special study wastes. Although the CDM report provides a general overview of state statutory and regulatory requirements addressing wastes from the extraction, beneficiation, and processing of ores and minerals in all 50 states, it was not designed to provide the detailed analysis of the scope, and in particular, the implementation of regulations that address mineral processing wastes, that EPA believes is necessary for this Report to Congress.

The second step of EPA's analysis, therefore, was to perform more detailed review of individual state statutes and regulations. Time and resource constraints made it impossible to perform a detailed regulatory analysis on all of the states that contain facilities that generate special mineral processing wastes. Consequently, this step in the analysis involved selecting a representative sample of the 29 states for further analysis. The goal of this selection process was to balance the need for comprehensive coverage of the mineral commodity sectors under study in this report with the need to work with a manageable number of states.

To ensure that the selected states provided comprehensive coverage of the sources of the mineral processing wastes in question, EPA employed the following criteria: (1) the percentage of facilities in each state and in each sector covered by the regulatory analysis; and (2) the percentage of total waste volume in each waste stream and sector covered by the regulatory analysis. Exhibit 2-4 displays the results of the evaluation of these criteria, which led to the selection of 18 of the 29 states for more detailed regulatory analysis. In selecting the 18 states, EPA was able to cover at least two-thirds of the facilities in all but one of the sectors (titanium tetrachloride) and at least 80 percent of the waste volume generated in each sector. Because a number of firms designated information as business confidential, EPA cannot publish all of the waste volume percentages; the Agency did, however, examine all of the waste volume data, including data from facilities that designated their waste generation rates as confidential, to ensure that the 18 studied states adequately represent the entire population of concern. The geographic distribution of the 18 selected states is displayed in Exhibit 2-5. The result of this step in the analysis was a summary, organized in a sector-by-sector format, that contains detailed information on the relevant statutes and regulations from the 18 selected states, along with shorter summaries addressing the eleven remaining states.

[12] Camp, Dresser, and McKee Federal Programs Corporation (CDM). 1989. State Regulation of Solid Wastes from the Extraction, Beneficiation, and Processing of Non-Fuel Ores and Minerals, June 2, 1989. Prepared for U.S. Environmental Protection Agency, Office of Solid Waste; Document Control Number: T1142-R00-DR-DELC-1.

Exhibit 2-4
Summary of Results of Selection Criteria Evaluation

Sector	Total Number of Facilities	Number of Facilities in Study States	Percent of Facilities in Study States	Percent Waste Volume Generated in Study States	Notes on Volume Data[a]
Alumina	5	4	80	93	
Chromate	2	2	100	NA[b]	2 of 2 facilities CBI
Coal Gasification	1	1	100	100	
Copper	10	9	90	90	3 of 10 facilities CBI
Elemental Phosphorus	5	5	100	NA[b]	3 of 5 facilities CBI
Ferrous Metals	28	19	68	80	2 of 28 facilities CBI
Hydrofluoric Acid	3	3	100	100	1 facility NR[c]
Lead	5	4	80	NA[b]	3 of 5 facilities CBI
Magnesium	1	1	100	100	
Phosphoric Acid	21	20	95	100	2 of 21 facilities CBI
Titanium	9	5	56	NA[b]	8 of 9 facilities CBI
Zinc	1	1	100	100	

(a) CBI = Confidential Business Information
(b) NA = Insufficient data to calculate accurately due to Confidential Business Information (CBI) status
(c) A single hydrofluoric acid facility owned by Dupont did not submit a survey response

While this more detailed study partially resolved the regulatory status of special mineral processing wastes, EPA found that the scope of state programs was not always clear from the state statutory and regulatory language that was reviewed. The final step of EPA's analysis, therefore, consisted of contacting state officials involved with the implementation of legal requirements in order to learn how those statutes and regulations are interpreted in practice, and to obtain facility-specific implementation information. The information compiled from these contacts was combined with the existing information on statutory and regulatory requirements to produce a final implementation analysis, which gives the clearest representation of the existing regulatory structure applicable to the 20 mineral processing wastes generated by the twelve commodity sectors considered in this Report to Congress.

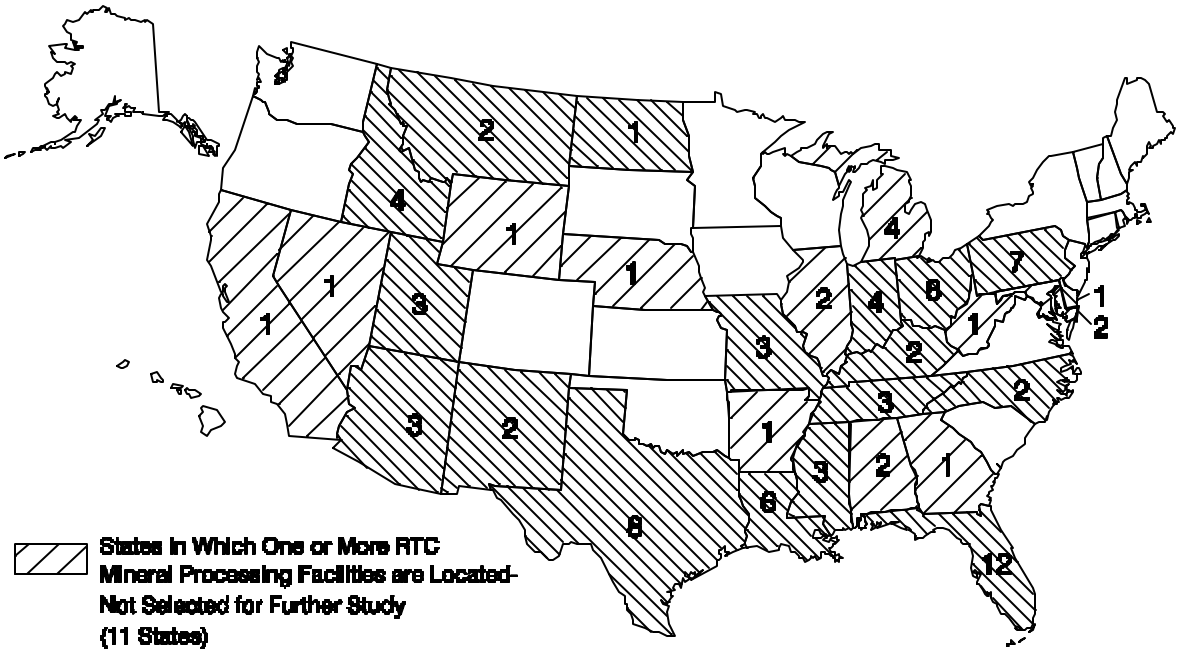
The findings of this analysis have been included in the sector-specific chapters that follow. For each of the 18 states containing a facility within a given sector, EPA has provided a description of the regulatory controls that apply to the management of special mineral processing wastes. A copy of the complete analysis can be found in Appendix D-2 to this report.

2.2.4 Waste Management Alternatives and Potential Utilization

Section 8002(p) of the RCRA statute requires that EPA consider alternatives to current disposal methods, as well as the current and potential utilization of the wastes addressed by the Report to Congress. In order to accomplish this, this report identifies demonstrated alternatives for waste management and utilization. The costs, current use, potential use, and environmental impact of each alternative are evaluated to the extent permitted by the information available.

Because the primary purpose of this report is to support a decision as to whether the mineral processing special wastes are to be regulated as hazardous wastes, EPA has focused its efforts and the discussion of waste management alternatives presented herein on those wastes that the Agency considers to

Exhibit 2-5
Distribution of States Selected For Further Statutory and Regulatory Analysis for the Mineral Processing Wastes Report to Congress



* The number in each state indicates the number of RTC mineral processing facilities located in the state.

be candidates for Subtitle C regulation. Wastes that exhibit no intrinsic hazard and pose no significant threat to human health or the environment under any realistic management scenario are not candidates for Subtitle C regulation. Therefore, extensive analysis and discussion of the ways in which facilities that generate such wastes might react to hazardous waste regulation is, in the Agency's view, unnecessary, because the question is moot. EPA has, nonetheless, provided (at a minimum) short discussions for each of the 20 special wastes considered in this report addressing potential waste management/utilization alternatives.

Methods

The first step in evaluating the alternatives for managing and utilizing the special mineral processing waste streams was to identify and obtain (through the National Technical Information Service and inter-library loans) any documents containing information on current or alternative waste management practices. Once documents from various sources were received, they were reviewed, and potentially useful information was extracted and organized according to the waste management or utilization option(s) to which it pertained. Alternatives for which there was insufficient information with which to evaluate the alternative are not discussed in this report, nor does the report consider alternatives that are experimental or unproven (i.e., have not seen full-scale application).

Information Collection

Computer-assisted literature searches were the primary means of identifying documents with information on the management and utilization of the special waste streams, though useful bibliographies were also obtained from

government agencies, trade associations, and research institutions. Information contained within the documents was supplemented by reviewing the 1989 National Survey of Solid Wastes from Mineral Processing Facilities (SWMPF Survey), and through direct contacts with private industry, trade associations, government agencies, contractors, and researchers.

More than 3,000 documents were identified as being potentially useful, primarily as a result of key word searches. A number of criteria were used to critically evaluate the 3,000 references and reduce the number of documents actually obtained and reviewed. Documents having titles with no clear relationship to any of the RTC study factors were eliminated from the Agency's preliminary list of potential information sources. EPA set priorities for procurement of the remaining documents after reviewing their abstracts (or key word descriptors if an abstract was not available), the time for delivery, and cost. Out of the possible 3,000 documents, over 300 were received and reviewed.

Additional information has been obtained through direct contact with Commodity Specialists and researchers at the U. S. Bureau of Mines, trade associations (e.g., the Florida Institute of Phosphate Research, The Fertilizer Institute), university researchers, and companies with some involvement in the management or utilization of one or more of the special study wastes. A comprehensive list of references that were collected and used by EPA in preparing this report may be found in Appendix B-5.

Evaluation of Alternatives

At a minimum, EPA's evaluation of each option includes a brief description of what the option involves (e.g., processing steps, equipment, and transportation); what is known about the current and potential use of the alternative; a discussion of the factors relevant to its regulatory status; and a discussion of the alternative's feasibility with respect to its cost and/or social acceptability. (The term "social acceptability" refers to whether an alternative is perceived to pose a potential threat to human health or the environment. Even in the absence of supporting data, perceived threats can influence the decisions of regulators, waste generators, and parties that might utilize a waste material.)[13] Where the information available allows, the discussion has been expanded to include data on costs, waste generation rates, and the chemical and physical characteristics of any waste management/ utilization residues. In many instances, the available data were not sufficient to allow EPA to evaluate the human health and environmental protection provided by the waste utilization and management alternatives identified. As a result, discussion of these options does not imply that EPA endorses their use.

2.2.5 Cost and Economic Impacts

Section 8002(p) of RCRA requires EPA to analyze "alternatives to current disposal methods" for solid wastes generated from the extraction, beneficiation, and processing of ores and minerals. EPA is also required to analyze "the costs of such alternatives." This section discusses methods for evaluating the costs and associated economic impacts of alternative waste management practices for the twelve mineral processing industry sectors and 20 special mineral processing wastes covered in this report. The analysis of costs and impacts is limited in scope to those waste streams that are candidates for regulation under Subtitle C of RCRA, i.e., those that exhibit one or more characteristics of hazardous waste and/or that have been associated with documented cases of danger to human health or the environment.

Costs may be imposed upon facility operators if changes in the regulatory requirements that apply to special mineral processing wastes management occur. The scope of this analysis is limited to the cost and economic impacts that would be associated with placing the wastes into three potential regulatory scenarios, focusing on the consequences of regulating these materials as hazardous wastes under Subtitle C of RCRA. EPA has attempted to predict how facility operators would react to having their wastes brought under the purview of different solid/hazardous waste management regulatory regimes, and has estimated the costs and impacts of the available waste management options under each regulatory scenario. EPA's approach in performing this analysis was to delineate all of the applicable

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[13] Collins, R.J. and R.H. Miller. 1976. Availability of Mining Wastes and Their Potential for Use as Highway Material - Vol. I: Classification and Technical Environmental Analysis. FHWA-RD-76-106, prepared for the Federal Highway Administration, May. p. 167.

requirements comprising each regulatory scenario, then develop plausible waste management sequences, or "trains", for each of the potentially affected special mineral processing wastes. Plausible management practices or trains are affected by the physical and chemical characteristics of the wastes in question, and by waste generation rates (all of which are, by definition, large), as well as by specific federal statutory and regulatory solid and hazardous waste management requirements. The ways in which prospective regulatory requirements translate into the "on the ground" waste management strategies that would be employed by affected facility operators are described in Appendix E-3 to this document.

In conducting its analysis of economic impact, EPA has utilized data on the recent performance of the individual industry sectors and the publicly-held corporations within them to characterize the financial condition of each potentially affected commodity sector. The incremental costs associated with alternative regulatory options are compared to several financial indicators in order to determine the relative magnitude of potential impacts. In addition, the Agency has conducted a qualitative analysis of market conditions facing each affected facility and sector, and has predicted the extent to which facilities potentially experiencing compliance costs would be able to pass through these costs to various input and product markets.

This section is organized into three major sub-sections in addition to this introduction. The first describes the four regulatory scenarios that have been developed for use in the cost analysis; the Agency believes that these scenarios span the range of the possible regulatory regimes that may be faced by mineral processors. The second sub-section provides a brief discussion of the costing assumptions and cost equations that have been used to conduct the analysis, and the third and final sub-section describes EPA's methodology for evaluating the economic impacts associated with changes in waste management costs.

Development and Application of Regulatory Scenarios

The waste management practices discussed in this report reflect the range of practices that are currently employed to manage special mineral processing wastes, as well as alternative management techniques that the Agency believes would be employed by facility operators in response to new regulatory requirements. They do not represent the only possible practices available, nor do they necessarily include the practices that would be explicitly required in the event of a change in regulatory status. Costs are estimated for four regulatory scenarios: (1) current management practices with no additional action required ("baseline"); (2) management practices required under full Subtitle C regulation ("Subtitle C"); (3) a less stringent set of management practices that could be implemented under Subtitle C regulation, allowing for the regulatory flexibility provided by RCRA §3004(x) ("Subtitle C-minus"); and (4) a scenario developed by EPA for this report that would address mineral production wastes under the auspices of RCRA Subtitle D ("Subtitle D-Plus").

Two of the alternatives to the baseline are based on Subtitle C of RCRA, and are immediately germane to the key regulatory decisions that EPA will make based upon this document and additional public comment (i.e., whether Subtitle C regulation of the 20 special wastes is or is not appropriate). Cost impacts of full Subtitle C regulation can be calculated with a relatively high degree of confidence because the waste management alternatives available under Subtitle C are well defined and have been extensively studied, at least for some industries. EPA has analyzed the Subtitle C-minus scenario because provisions of Section 3004(x) of RCRA, as added in the 1984 HSWA amendments to the Act, allow flexible Subtitle C regulation for hazardous wastes generated by the mining and mineral processing industries, as well as certain other special

waste categories.[14] Under this provision, many significant RCRA requirements[15] for wastes may be modified

> "...to take into account the special characteristics of such wastes, the practical difficulties associated with implementation of such requirements, and site-specific characteristics, including but not limited to the climate, geology, hydrology and soil chemistry at the site, so long as such modified requirements assure protection of human health and the environment."

Costs associated with the remaining regulatory alternative, the "Subtitle D-Plus" management program, on the other hand, are intended to be illustrative only. Although EPA is in the process of developing a Subtitle D program for mineral extraction and beneficiation wastes, the specific elements of this program remain to be determined. Whether and to what extent the ultimate mining wastes regulatory program resembles the Subtitle D-Plus regulatory scenario described here cannot be known at this juncture. EPA has, nonetheless, estimated the costs and impacts of Subtitle D regulation of special mineral processing wastes in this report, in the expectation that some of these studied wastes may ultimately be regulated under the Subtitle D mining wastes program, in whatever form it is finally promulgated.

Management costs associated with each pertinent regulatory scenario are estimated for each facility being analyzed by identifying the specific items (and their costs) that are currently employed (in the baseline case) and that would be required under the regulatory alternatives. EPA utilized data contained in facility responses to the 1989 SWMPF survey to characterize current practices. The Agency then calculated the costs associated with each practice employed (e.g., design, construction, and operation of an unlined surface impoundment, waste stabilization, installation and operation of ground water, surface water, and/or air monitoring equipment); the sum of these costs is the total management cost at a given facility.

This technology- and facility-specific approach has resulted in management cost estimates that vary widely among facilities, even among those in the same commodity sector. For example, EPA's cost estimates for baseline practices account for the presence of waste management controls such as run-on and run-off control systems and ground water monitoring. Facilities that currently employ these controls have higher current (baseline) waste management costs (all else being equal) than facilities that do not. Consequently, prospective Subtitle C regulation, and its attendant technical requirements (e.g., run-on and run-off controls, ground water monitoring) have reduced compliance cost implications at such facilities. Because EPA's cost analysis relies upon individual cost elements rather than unified cost functions, this variability in current waste management cost and, therefore, the incremental waste management cost associated with regulatory alternatives, can be accounted for in full.

Baseline Scenario

The baseline regulatory scenario assumes that existing waste management practices will remain unchanged. The waste management practices discussed in the sector-specific chapters that follow comprise the waste management technologies employed under this scenario. In virtually all cases, assumed current waste management practices are based upon information submitted to EPA in the form of responses to the 1989 National Survey of Solid Wastes from Mineral Processing Facilities, supplemented by information obtained during visits to some facilities. In the few instances in which management practice information was missing or incomplete, the Agency assigned one or more management technologies based upon knowledge of the common practices used by other similar (e.g., same commodity sector and size of operation) facilities.

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[14] Specifically, cement kiln dust waste and fly ash, bottom ash, slag, and flue gas emission control wastes generated primarily from combustion of fossil fuels (principally coal).

[15] Specifically, RCRA sections 3004(c) through (g) (land disposal restrictions), (o) (minimum technology standards), (u) corrective action for continuing releases), and 3005(j) (permitting of interim status treatment, storage, and disposal surface impoundments).

The most common current waste management technologies for solid and some sludge materials include on-site, unlined landfills; waste piles without a cover or a base; gypsum stacks; and recycling. Wastewaters tend to be managed in on-site, unlined surface impoundments (some in combination with a gypsum stack); and in a few cases, synthetic- or clay-lined surface impoundments. Some portion of these wastewater streams is recycled at nearly all facilities.

Several of the facilities examined here, particularly in the ferrous metals commodity sector, already are interim status or permitted Subtitle C Treatment, Storage, and Disposal Facilities (TSDFs). Such facilities are already subject to many of the requirements that are evaluated in this report (e.g., Subtitle C permitting, financial assurance, corrective action for continuing releases requirements), and hence, would not experience incremental compliance costs associated with these specific regulatory requirements if the special waste(s) that they generate were to be removed from the Mining Waste exclusion. EPA has, accordingly, reflected this fact in conducting its cost and economic impact analysis.

The "Baseline" scenario for the industry sectors covered by this report would occur under a regulatory determination by EPA that the special mineral processing wastes that are currently excluded from regulation under Subtitle C of RCRA do not require regulation as hazardous wastes. Even with such a regulatory determination, however, some changes in waste management practices may be required. The mineral processing industry, which has historically been exempt from the federal hazardous waste management regulations under RCRA, has recently had this protection removed by a series of EPA rulemakings that were concluded on January 23, 1990 (55 FR 2322). As of the effective date of this latest rulemaking, all mineral processing wastes except the 20 specific wastes considered in this report are subject to regulation as hazardous wastes (i.e., under RCRA Subtitle C) if they exhibit one or more characteristics of hazardous waste. In addition, six mineral processing wastes have been listed as hazardous wastes (see 53 FR 35412, September 13, 1988). EPA believes that many of the facilities considered in this report generate wastes that are newly subject to these requirements. Consequently, existing "baseline" management practices that are currently applied to special wastes at some of these facilities may change even if these materials are not removed from the Mining Waste Exclusion.

In addition, several states have imposed or are in the process of imposing new regulatory requirements on the operators of mineral processing facilities. For example, the State of Florida has issued a policy directive requiring that all new phosphogypsum stacks or lateral expansions of existing stacks have a clay liner; the State Department of Environmental Regulation has also indicated that it plans to initiate a formal rulemaking process for the development of phosphogypsum management regulations.

In general, however, the scope of EPA's analysis is limited to an examination of special mineral processing waste management as it is currently conducted, that is, as reported by facility operators in the 1989 SWMPF Survey. Nonetheless, where appropriate, the Agency has indicated when and in what manner existing management practices are expected to change because of non-RCRA federal or state-level regulatory activity.

Full Subtitle C Scenario

The full Subtitle C ("Subtitle C") scenario examined here for the special wastes is based on the premise that any of the 20 wastes for which (1) existing practices have been shown to have caused environmental damages, or (2) have exhibited risk in the risk assessment process described above, including any that exhibit one or more RCRA hazardous characteristics (EP-toxicity, corrosivity, ignitability, or reactivity) may be regulated under Subtitle C and, thus, subject to the technical requirements of 40 CFR Part 264. The remaining wastes, which have not shown significant potential risk or documented damages and do not exhibit a hazardous characteristic, are assumed to not be candidates for Subtitle C (or Subtitle C-minus) regulation, and hence, have not been analyzed under these scenarios.

EPA has examined the full array of Subtitle C regulatory requirements, and has identified those that would be relevant from the standpoint of managing mineral processing wastes (some Subtitle C requirements, such as those addressing the management of used oil, solvents and dioxins, etc. are clearly not germane to the present study). Relevant regulatory provisions are summarized in Appendix E-1 to this document. The Agency then identified and categorized all of these requirements that might have cost implications. In other words, the focus of EPA's compliance cost analysis is on the specific regulatory requirements that would impose new costs on the operators of the mineral processing facilities considered in this study. These groups of cost-related requirements are listed in Exhibit 2-6 and serve as the starting point for EPA's compliance cost analysis. Additional detail regarding the manner in which EPA has computed the costs of these individual provisions is provided in Appendix E-3.

Subtitle C-Minus Scenario

To assess the potential costs and impacts of less stringent regulation, EPA has evaluated an intermediate Subtitle C scenario ("Subtitle C-Minus") that assumes that EPA exercises all of the regulatory flexibility provided by Section 3004(x) of RCRA. Section 3004(x) does not give EPA authority to waive Subtitle C requirements based on cost alone. Rather, this provision allows EPA to provide some regulatory flexibility to mitigate the economic impacts of Subtitle C regulation on the industries generating certain special wastes, provided that adequate protection of human health and the environment is ensured. This flexibility allows EPA to modify the relevant provisions to take into account the special characteristics of (in the current context) mineral processing wastes, practical difficulties in implementing the specific RCRA Subtitle C requirements, and site-specific characteristics.

For purposes of estimating the costs of this regulatory alternative in this Report to Congress, EPA has identified and evaluated what it believes would be the minimum allowable extent of regulation under Subtitle C (i.e., the maximum allowable application of regulatory flexibility) that comports with the statutory requirement of ensuring adequate human health and environmental protection. EPA stresses, however, that the hypothetical Subtitle C-Minus scenario analyzed here does not reflect the Agency's actual determination as to which Subtitle C requirements might be altered and to what extent through the 3004(x) mechanism for any of the wastes or industries studied in this report, though it does reflect an attempt to craft tailored Subtitle C requirements that are operationally and economically feasible at the facility level. Moreover, EPA believes that the scenario provides a meaningful "lower bound" for estimating the potential compliance costs that would be imposed under Subtitle C. In other words, estimated Subtitle C-Minus compliance costs and associated impacts are likely to understate the actual impacts that would be imposed if the special mineral processing wastes are withdrawn from the Mining Waste Exclusion, at least for some commodity sectors and facilities.

This scenario uses many of the same assumptions as the full Subtitle C regulatory scenario, with three notable exceptions:[16]

- The prohibition on placing liquids in Subtitle C landfills does not apply;
- Land Disposal Restrictions do not apply; and
- On-site waste management practices, for special mineral processing wastes meet only pre-HSWA Subtitle C technological requirements, rather than the minimum technology required under 3004(o) and 3005(j) of the amended RCRA statute.

Potentially hazardous wastes managed on-site are awarded this regulatory flexibility. Candidate Subtitle C wastes managed off-site, however, are assumed to be sent to facilities that comply with all provisions of Subtitle C. Most other assumptions made for the full Subtitle C regulatory scenario with respect to the choice of waste management technologies apply to the Subtitle C-minus regulatory scenario as well.

Nonetheless, one important aspect of the way in which EPA has evaluated the implications of RCRA §3004(x) is that site-specific variability in risk potential and waste-specific variability in existing management practices has been explicitly factored into the analysis. Subtitle C-Minus waste management requirements are less stringent at facilities at which the potential for contaminant release and transport are low than at facilities at which such potential is high. For example, all else being equal, requirements at a facility overlying shallow ground water with high local net recharge and porous soils are more stringent than at an otherwise similar facility located in an arid region with deep ground water and relatively impermeable soils. Additional detail

[16]As explained further below, EPA has not estimated corrective action costs in preparing this report, though relaxation of corrective action requirements is a potentially significant aspect of RCRA §3004(x).

Exhibit 2-6

Regulatory Requirements: Subtitle C Scenario

Category	Requirement
RCRA §3010 Notification	▾ Notification
Permit Requirements	▾ Exposure Potential Information ▾ Chemical and Physical Analysis of Waste(s) ▾ Waste Analysis Plan ▾ Site Security ▾ Inspections ▾ Location Standard Studies ▾ Topographical Map ▾ Ground-Water Protection Study
Preparedness and Prevention	▾ Internal Communication/Alarm System ▾ Water Sprinkler System
Design and Operating Criteria	▾ Land Disposal Restrictions ▾ Tank Requirements: - Secondary Containment - Construction Requirements ▾ Surface Impoundment Requirements: - Existing -- Liner or No Migration Demonstration - New -- Double Liner, Leachate Collection System ▾ Waste Pile Requirements: - Liner - Leachate Collection and Removal System - Run-on/Run-off Controls - Wind Dispersal Controls ▾ Landfill Requirements: - Existing -- Liner and Leachate Collection System - New -- Double Liner, Dual Leachate Collection System - Run-on/Run-off Controls - Wind Dispersal Control ▾ Land Treatment Requirements: - Proof of Contaminant Degradation, Transformation, or Immobilization - Run-on/Run-off Controls - Wind Dispersal Control - Permit for Field and Greenhouse Testing - Soil/Liquid Monitoring - Crop Distribution Plan
Monitoring	▾ Ground-Water Monitoring
Corrective Action	▾ Corrective Action Plan ▾ Corrective Action Activities - Source Control - Remediation
Closure	▾ Remove/Decontaminate Residues ▾ Stabilize, Cover Waste(s)
Post-Closure Care	▾ Monitoring ▾ Maintenance ▾ Leachate Collection ▾ Run-on/Run-off Control

Financial Responsibility	▾ Environment Impairment Liability ▾ Sudden Release of Contaminants ▾ Non-Sudden Release of Contaminants

regarding the development and application of the Subtitle C-Minus scenario to individual waste streams and facilities is provided in Appendix E-3 to this report.

Subtitle D-Plus Scenario

The third and final regulatory alternative considered by the Agency for this analysis of regulatory costs and impacts is regulation under one possible approach to a RCRA Subtitle D (solid, non-hazardous waste) program. The approach described here has been developed solely for analytical purposes by EPA staff, and is tailored to address some of the special characteristics of mineral processing wastes. The reason for inclusion of a Subtitle D scenario in this report is that the Agency is presently developing a tailored program to address mineral extraction and beneficiation wastes under Subtitle D, and could consider applying this program to any of the 20 mineral processing wastes that remain excluded from regulation under RCRA Subtitle C after the regulatory determination that will follow, and be based upon, this report and on changes made due to comments received from the public and inter-agency discussions.

Substantively, the Subtitle D-Plus program would be a state-implemented program based on a minimum set of federal technical criteria and provisions for state program primacy. The technical criteria contained within the program would consist essentially of provisions for the state establishment of media-specific performance standards for ground water, surface water, air, and soils/surficial materials. The Subtitle D-Plus scenario also contains technical criteria for a variety of required owner/operator activities, including design and operating criteria, monitoring criteria, corrective action requirements, closure and post-closure care criteria, and financial responsibility requirements. These prospective regulatory provisions are summarized in Appendix E-2 to this document. The Agency has also identified and categorized all provisions of the Subtitle D-Plus scenario having potential cost implications. These groups of requirements are listed in Exhibit 2-7 and serve as the starting point for EPA's compliance cost analysis. Additional detail regarding the manner in which these requirements have been applied to individual facilities is provided in Appendix E-3 to this document.

Costing Assumptions and Methods

This section provides a brief overview of the methodology and assumptions that EPA has used to estimate compliance costs for regulation of special mineral processing wastes under the four regulatory scenarios described above.

Costs of regulations can be viewed in two contexts, economic and financial. The two contexts consider regulatory costs in two very different ways for different purposes. The economic context considers impacts on society at large, while the financial context evaluates effects on firms, facilities, and other discrete entities. For this report, EPA has considered only the financial context, that is, impacts on firms and facilities. Thus, in keeping with the statutory directives articulated at RCRA §8002(p), EPA's analysis employs a financial perspective which attempts to evaluate the actual costs that would be incurred by those firms subject to regulation. The willingness and ability of firms to comply with the regulations (instead of discontinuing the regulated activity) are influenced by the magnitude and timing of compliance costs, market and competitive factors, and firm-specific financial considerations, such as the costs incurred by the firms to obtain capital.

Consequently, in conducting this analysis, EPA has employed data and assumptions that reflect the focus on the individual facility/firm. For example, the Agency has employed a discount rate that approximates the likely true cost of obtaining financing for regulatory compliance-related expenditures, rather than a "social" discount rate, or cost to society, and has computed costs on an after-tax basis, to better reflect the financial impacts that might be imposed by new regulatory requirements.

Exhibit 2-7
Regulatory Requirements: Subtitle D-Plus Program Scenario

Category	Requirement
Regulated Materials Characterization	Regulated Materials Characterization
Design and Operating Criteria	▾ Structural Stability ▾ Run-on/Run-off Controls ▾ Land Application Requirements ▾ Biological Resources Protection ▾ Site Access Control ▾ Inspections ▾ Location Standards: - Floodplains - Seismic Zones, Unstable/Fault Areas - Karst Terrane - Wellhead Protection Areas ▾ Unit-Specific Requirements: - Waste Piles - Landfills - Surface Impoundments - Gypsum Stacks - Tank Treatment Systems
Monitoring	▾ Ground-Water Monitoring ▾ Surface Water Monitoring ▾ Air Monitoring
Corrective Action	▾ Corrective Action Plan ▾ Corrective Action Activities: - Source Control - Remediation
Closure	▾ Final Regulated Materials Characterization ▾ Continued Compliance with Design and Operating Criteria ▾ Closure Plan ▾ Closure Activities - Run-on/Run-off Controls - Stabilization/Neutralization - Wind Dispersal Control - Removal of Materials, Decontamination (Tanks)
Post-Closure Care	▾ Continued Compliance with Design and Operating Criteria ▾ Post-Closure Care Plan ▾ Post-Closure Care Activities - Maintenance of Closure Activities
Financial Responsibility	▾ Environmental Impact Liability ▾ Corrective Action ▾ Closure/Post-Closure Care

Cost Estimating Methods

In EPA's cost estimating analysis, the first step was to estimate the costs of waste management activities and the distribution of these costs over time. The second step was to discount all future costs to the present and then calculate the equivalent annualized compliance cost (ACC), incorporating the specific requirements of the context being examined. The annualized compliance cost is the average annual cost (annuity) over the life of the facility that has the same total present value as the actual expenses incurred at their actual times. This method offers the distinct advantage

of allowing comparisons between scenarios and among industrial sectors that may incur compliance costs of different types and/or at different times.

EPA has estimated the costs of waste management for each individual facility that may be affected by new regulatory requirements for up to four waste management scenarios. Cost equations developed from an engineering analysis of each technology are used to estimate the costs for each individual management practice used. The sum of the costs equals the total facility cost. Under three alternative regulatory scenarios examined here, four types of costs can be incurred:

- Capital investment costs, both direct and indirect, incurred initially and in each year that the technology is operated (e.g., construction of new disposal units). Capital costs incurred annually are treated as operating costs;
- Annual operating and maintenance (O&M) costs, both direct and indirect (e.g., materials, labor, utilities);
- Capital costs (direct and indirect) for facility closure; and
- Annual costs of post-closure care and maintenance.

Most of the facilities of interest are not currently required to perform formal closure and post-closure care activities. Accordingly, in EPA's analysis, most facilities are assumed to experience only capital and O & M costs under the baseline scenario.

Costing Equations

EPA has developed cost estimating equations that reflect the current waste management practices employed by the facilities of interest, as well as the practices that would be required under alternative regulatory scenarios. In analyzing each facility, total management costs are built up by determining which specific requirements apply (e.g., obtaining permits, installing run-on/run-off controls, constructing a tank treatment system), estimating the cost of each requirement for a given waste stream at the facility, and adding the costs of each requirement. EPA used these technology-specific costs to calculate the total annual compliance costs (ACCs) for utilizing a given management requirement. The ACC for a waste management practice is the sum of the ACCs for the treatment, storage, and disposal steps in that waste management practice. In this way, all costs of currently used management techniques are accounted for, and only the items that would actually apply at a particular facility are used in calculating incremental waste management costs.

Analytical Assumptions

In general, most of the waste streams considered in this report do not exhibit characteristics of hazardous waste. In conducting this cost analysis, EPA has assumed that waste streams are potentially hazardous at individual plants only if data submitted by industry or EPA sampling indicate failure of hazardous waste characteristic tests, for most waste streams.[17] In these cases, the waste(s) are assumed to be candidates for Subtitle C and Subtitle C-minus regulation, and are examined in the cost analysis on that basis. Otherwise, wastes are assumed to be non-hazardous, except for waste streams which may pose risks that are not addressed by current Subtitle C hazardous waste characteristics tests (e.g., radioactivity), or for which special circumstances justify a modified cost analysis approach.

For those wastes assumed to be candidates for regulation under one or more alternative scenarios, it is often the case that more than one management train would be available. In these instances, and in keeping with the profit-maximizing behavior expected of facility operators, the Agency selected the least-cost alternative for managing each waste under each regulatory scenario. The costs of each scenario/least-cost management practice combination were

[17] The preponderance of evidence indicates that a small number of wastes are likely to exhibit hazardous characteristics at most (including unsampled) facilities; in its costing analysis, EPA has assumed that these wastes would exhibit characteristics of hazardous waste at all facilities unless actual sampling data indicated a contrary result.

then compared to the estimated cost of current management practices, in order to develop incremental regulatory compliance costs.

In estimating costs for specific waste management technologies, the Agency made a number of costing assumptions, which are described in Appendix E-3 to this report. Detailed results of EPA's compliance cost analysis are presented in a technical background document that may be found in the supporting docket for this report.

Evaluation of Economic Impact

Section 8002(p) requires that EPA examine, in addition to incremental costs, the impacts of waste management alternatives on the use of natural resources, and, by implication, the entities (firms) that would be subject to new waste management requirements. If subjected to new regulatory requirements, firms in affected mineral processing sectors will incur compliance costs which will generate both direct and indirect economic impacts. Direct impacts on the company include lower profits and the reduced value of assets because of anticipated reductions in future profits. Indirect impacts are associated with the "pass through" of compliance costs either backwards in the form of lower wages paid to workers and/or lower prices paid to suppliers, or forward in the form of higher prices charged to customers. Additional direct and indirect impacts on the local or national economy are associated with the possibility of plant closures and associated job and income losses, reductions in federal, state, and county tax revenues, possible changes in the U.S. balance of trade, and increased reliance on foreign sources for critical mineral supplies.

EPA's economic impact assessment of prospective requirements has two parts. First, the Agency put the compliance costs for each affected commodity sector into context by comparing them with other cost and sales figures for the sector. The Agency considered compliance costs to be possibly significant and requiring further evaluation if they were greater than or equal to:

- 1 percent of sales and/or value added;
- 5 percent of current capital outlays i.e., sustaining capital (based on capital compliance costs).

The data used to apply these screening tests are based on standard accounting measures of cost and financial performance, and in general were obtained from published sources. Throughout, EPA has conducted its analysis on a facility-specific basis.

When EPA determined that compliance costs for a facility or mineral processing sector exceeded the screening threshold value for at least two of the indices, the Agency examined the competitive position of affected firms within the sector and conditions in relevant input and product markets to assess the ability of affected firms to pass through compliance costs to workers, to suppliers, and to customers, including foreign markets. The Agency based this assessment on information about industry and market trends, buyer and seller concentration, and inter-industry dependencies. Where the possible pass-through of compliance costs was to other sectors of the U.S. economy, they were viewed as transfers of economic impacts or shifts in the "incidence" of compliance costs; where the pass-through was to foreign markets EPA viewed them as potential reductions in U.S. compliance costs and economic impacts.

The following paragraphs describe the data sources that EPA used to characterize the financial performance and industry and market characteristics for each mineral commodity sector. Then, the Agency discusses the methodology for evaluating the significance of compliance costs for each sector and for assessing the most likely distribution of compliance costs across market levels. The sector-specific discussions that follow this chapter provide economic profiles of each affected industrial sector, including information about product markets, input factor markets, and trends in production and consumption.

Data Sources

The U.S. Bureau of Mines provided most of the industry and market data on which EPA has based its assessment of the economic conditions facing each mineral commodity sector. The Minerals Yearbook 1987 and Mineral Commodity Summaries 1989 are the major published sources of data from the Bureau of Mines, but additional BOM data were obtained from contacts with the Bureau's Mineral Commodity Specialists. Data from the Technical Background Document[18] and trade journals, including Chemical & Engineering News, were also used. World Metal Statistics, published by the World Bureau of Metal Statistics, was used to characterize global markets for some mineral commodity sectors.

Methodology

The economic impact analysis was conducted in two steps. The first includes a set of screening indices to test the significance of compliance costs. These indices were based on capital investment requirements and other compliance costs in relation to current costs, sales, and financial performance indicators for each sector. For sectors where the screening analysis suggested potentially significant compliance costs, the Agency further evaluated the nature and incidence of potential economic impacts, including a review of the competitive position of affected facilities within each sector and in relevant input and product markets to determine pass-through potential. Combined, the two parts of the analysis describe the magnitude of economic impacts and the way that they can be expected to spread from regulated mineral processing sectors to other segments of the U.S. economy.

Screening Level Test of Significance The objective of this screening analysis was to determine which affected facilities and mineral commodity sectors might experience significant compliance costs. The screening indices used to determine significance are displayed in Exhibit 2-8. The underlying data used to compute the indices are described in Appendix E-4 to this document, while the results of the ratio analysis are presented in tabular form by commodity sector in Appendix E-5.

In general, if more than two of the screening indices for a given sector were exceeded, EPA assumed that the economic impact on that facility or sector might be significant, and evaluated compliance costs in greater depth. Facilities and sectors facing compliance costs below the thresholds were regarded as unlikely to experience significant economic impacts associated with new regulatory requirements. For those sectors with potentially significant compliance costs, EPA then assessed the most likely distribution or "incidence" of economic impacts.

Incidence of Impacts The cost of regulatory compliance is not incurred only by firms in the regulated sector. To prevent plant closures and layoffs, workers may make wage concessions; to prevent supply shortages, customers may pay higher prices (because the affected industries generally produce intermediate products); and to maintain markets, suppliers may accept lower prices for mineral processing inputs. This may cushion the direct impact of compliance costs on the regulated industry and spread them to other segments of the U.S. economy.

In general, the pass-through of compliance costs follows the path of least market resistance. Where all facilities in the affected sector face similar compliance costs and produce commodities for which there are few alternative supply sources or substitute materials, there is a high likelihood that moderate compliance costs can be passed forward in the form of higher product prices. On the other hand, where only a small proportion of facilities in a sector are affected, or alternative supplies or substitute materials are abundant, the opposite may be true. Similar possibilities exist in input and labor markets where the regulated sector may be able to negotiate wage or price concessions in order to remain in operation or continue operating at current levels.

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[18] U.S. EPA, 1989. Technical Background Document -- Development of the Cost, Economic, and Small Business Impacts Arising from the Reinterpretation of the Bevill Exclusion for Mineral Processing Wastes, Economic Analysis Staff, Office of Solid Waste, August 18.

Exhibit 2-8

Indicators of Significant Economic Impact

Screening Index	Symbol	Description
Compliance Costs as Percent of Sales	CC/VOS	Percent by which product price would need to increase to maintain current production and profits with compliance
Compliance Costs as Percent of Value Added	CC/VA	Percent reduction in value added due to outlays for compliance
Capital Investment Requirements as Percent of Current Capital Outlays	IR/K	Percent of current capital expenditures that would need to be diverted to compliance uses if total capital outlay remained constant

In all cases, the ability to pass through compliance costs depends on the initial incidence of compliance costs within the affected sector and the concentration and interdependency of buyers and sellers in relevant input and product markets.

The price sensitivity of buyers and sellers in relevant markets cannot be estimated precisely but enough information is available about industry and market conditions and relevant market trends to assess the most likely distribution of economic impacts. For example, current wages and salary data can give an indication of whether some firms may be able to pass compliance costs back to labor. For purposes of analysis, information about factor and product markets related to each affected mineral processing sector has been organized on the basis of the following criteria:

MARKET CONCENTRATION

- Affected sectors as sellers in U.S. and world markets
- Affected sectors as buyers of inputs and labor

I N T E R I N D U S T R Y D E P E N D E N C E

- Availability/cost of alternatives
- Availability/cost of substitutes

INDUSTRY/MARKET TRENDS

- U.S. mineral production and consumption
- Global mineral production and consumption
- U.S. mineral imports and exports

VALUE ADDED

- Contribution of material and processing costs to the price of fabricated/manufactured product

Based on both quantitative and qualitative assessments of the available industry and market information, EPA estimated the most likely incidence of compliance costs across the following market segments:

Segment	Type of Impact
▾ Regulated Industry	▾ Lower Profits
▾ Labor	▾ Lower Wages/Fewer Jobs
▾ Supplying Industries	▾ Lower Input Prices/Smaller Markets
▾ Intermediate U.S. Product Markets	▾ Higher Product Prices
▾ Final U.S. Markets	▾ Higher Product Prices
▾ Foreign Markets	▾ Higher Product Prices

In general, the type of impact in the regulated industry involves higher costs and lower profits, including the possibility of continual negative profits and associated plant closures. The type of impact in other segments involves adverse changes in market prices (higher prices for buyers and lower prices for sellers of mineral processing inputs) and reductions in market size.

The levels of impacts were assessed on the basis of relatively near-term changes in market conditions. For example, the ability of the affected firms to pass-through compliance costs in the form of higher product prices would be shown to mitigate the direct impact of the proposed rule on the regulated industry. The possibility that higher U.S. prices might then attract new foreign competition, increase imports, and eventually result in lower U.S. product prices has not been factored into EPA's analysis.

2.2.6 Summary

Based upon the analysis of the study factors found at §8002(p) as described above, EPA has arrived at preliminary findings that are relevant to the appropriate regulatory status under RCRA of the special wastes from mineral processing. These findings were arrived at through an explicit evaluation process, which is described below. In this process, the Agency considered the study factors in a step-wise fashion, first assessing the need for additional regulatory controls (or absence thereof), then evaluating the options for appropriate requirements that could be applied to each individual waste stream for which additional controls might be in order. In applying this framework, EPA has employed a number of assumptions, which are described in the following paragraph. Each sector-specific chapter in this volume concludes with a summary that highlights the major findings of this study for the waste(s) of interest, organized by the issues presented in sequence below. EPA's preliminary conclusions regarding the appropriate regulatory status of each special mineral processing waste are presented in Volume I of this report.

The first assumption that the Agency has employed is that explicit decision criteria were needed and should be applied uniformly to all of the special study wastes. In this manner, consistent and reasonable decisions regarding the need for additional regulatory controls can be achieved. The second major assumption guiding EPA's decision-making process was that the study factors that are most important in establishing the regulatory status of the special wastes are risks posed and documented damages caused by the wastes, and the costs and impacts that would be associated with more stringent regulatory controls. The reason for this is that in the absence of potential risk and/or documented damages, there is no need for hazardous waste regulation under RCRA Subtitle C (the key issue in question); if greater regulatory controls are needed because of significant potential or documented danger, the costs and impacts of regulatory controls are the critical factor in determining whether a given alternative would lead to the desired outcome (adequate protection of human health and the environment, and continued operation of the affected

industries). EPA also believes that it has developed and analyzed regulatory compliance scenarios that are realistic from an operational and engineering standpoint, and that are likely to be adequately protective of human health and the environment, i.e., could be implemented by facility operators and would result in societal benefits. Finally, because the waste management controls that might be imposed under the auspices of Subtitle D or developed under the regulatory flexibility provided by RCRA §3004(x) are not well-defined at this juncture, the focus of EPA's comparisons of the desirability of Subtitle C and Subtitle D regulation has been on the full Subtitle C and Subtitle D-Plus scenarios, rather than on Subtitle C-Minus and baseline conditions. Nonetheless, because of the high volume nature of the special mineral processing wastes, EPA believes that an effective and appropriate regulatory program for the management of these materials should be tailored to reflect their unusual characteristics; the Agency's preliminary assessment of how these programs might be tailored in this way is reflected in the Subtitle C-Minus and Subtitle D-Plus scenarios described in the previous section.

Evaluation Criteria

Step 1. Does management of this waste pose human health/environmental problems? Might current practices cause problems in the future?

Critical to the Agency's decision-making process is whether each special waste either has caused or could cause human health or environmental damage. To resolve this issue, EPA has posed the following key questions:

1. Has the waste, as currently managed, caused documented human health impacts or environmental damage?
2. Does EPA's analysis indicate that the waste could pose significant risk to human health or the environment at any of the sites that generate it (or in off-site use), under either current management practices or plausible mismanagement scenarios?
3. Does the waste exhibit any of the characteristics of hazardous waste?

If the answer to any of these three questions was yes, then EPA concluded that further evaluation was necessary. If the answer to all of these questions was no, then the Agency concluded that regulation of the waste under RCRA Subtitle C is unwarranted.

Step 2. Is more stringent regulation necessary and desirable?

If the waste has caused or may cause human health or environmental impacts, then EPA concluded that an examination of alternative regulatory controls was appropriate. Given the context and purpose of the present study, the Agency focused on an evaluation of the likelihood that such impacts might continue or arise in the absence of Subtitle C regulation, by posing the following three questions:

1. Are current practices adequate to limit contaminant release and associated risk?
2. What is the likelihood of new facilities opening in the future and generating and managing the special waste in a different environmental setting than those examined for this report?
3. Are current federal and state regulatory controls adequate to address the management of the waste?

If current practices and existing regulatory controls are adequate, and if the potential for actual future impacts is low (e.g., facilities in remote locations, low probability of new facilities being constructed), then the Agency tentatively concluded that regulation of the waste under Subtitle C is unwarranted. Otherwise, further examination of regulatory alternatives was necessary.

Step 3. What would be the operational and economic consequences of a decision to regulate a special waste under Subtitle C?

If, based upon the previous two steps, EPA believed that regulation of a waste under Subtitle C might be appropriate, then the Agency evaluated the costs and impacts of two regulatory alternatives that are based upon Subtitle C, and one alternative that reflects one possible approach that might be taken under RCRA Subtitle D. The focus of this inquiry was whether the magnitude and distribution of regulatory compliance costs might jeopardize the continued economic viability of one or more generators if the waste were to be regulated under the Subtitle C regulatory scenario. The key questions in the Agency's decision-making process were as follows:

1. Are predicted economic impacts associated with the Subtitle C scenario significant for any of the affected facilities?
2. Are these impacts substantially greater than those that would be experienced under the Subtitle D-Plus scenario?
3. What is the likely extent to which compliance costs could be passed through to input and/or product markets, i.e., to what extent could regulatory cost burdens be shared?
4. In the event that significant impacts are predicted, might a substantial proportion of domestic capacity or product consumption be affected?
5. What effects would hazardous waste regulation have upon the viability of the beneficial use or recycling of the special waste?

In EPA's judgment, absence of significant impacts or high pass-through potential suggested that Subtitle C regulation might be appropriate for wastes that pose significant risk. In cases in which even relaxed Subtitle C standards would impose widespread and significant impacts on facilities, and/or deter the safe and beneficial use of the waste, EPA concluded that regulation under some form of Subtitle D program might be more appropriate.